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AREA SOURCE EMISSION INVENTORY FOR FULTON, DEKALB, COBB, CLAYTON, AND GWINNETT COUNTIES, GEORGIA. VOLUME I

PEDCo-Environmental Specialists, Incorporated

Prepared for:

Environmental Protection Agency

September 1975

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Volume I

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Volume I

Prepared by

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16. Abstracts

This project was undertaken to prepare an inventory of area sources of particulates, SO_x, CO, HC, and NO_x emissions in the five-county metropolitan Atlanta area for use in analysis and modeling of air quality in this designated Air Quality Maintenance Area for the period 1975-1985. Base year (1973) emissions are projected to 1975, 1980, and 1985, as specified in EPA's regulations governing the preparation of Air Quality Maintenance Plans. Total emissions in thirty categories, including fugitive dust, were allocated into grid squares covering the entire area. The emissions for each grid were estimated by use of EPA's "Area-2 Program." Required input data for this program, aside from pertinent grid information, are fuel usage totals and emission factors. The program was modified by PEDCo to accept data input from up to twenty-five source categories requiring both emission calculation and apportioning, and from ten other categories which are best treated as "point sources."

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Statistical inference
Sulfur oxides
Suspended particulates

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Mr. Randy Mayfield was the Project Officer for the U.S. Environmental Protection Agency. The project team is appreciative of the assistance and cooperation extended by Mr. Mayfield, other staff members of EPA Region Office IV, and Mr. James Mullins, Georgia Department of Natural Resources.

TABLE OF CONTENTS

		Page
LIST OF FIGURES		iv
LIST OF TABLES		v
SUMMARY		vi
1.	GENERAL METHODOLOGY	1-1
2.	STATIONARY SOURCE FUEL COMBUSTION	2-1
	Bituminous Coal	2-1
	Fuel Oil - Distillate	2-7
	Fuel Oil - Residual	2-13
	Natural Gas	2-16
	LPG	2-22
	Wood	2-26
3.	MOBILE SOURCES	3-1
	Gasoline Highway Motor Vehicles	3-1
	Diesel Highway Motor Vehicles	3-13
	Aircraft	3-17
	Rail Locomotive	3-25
	Vessels	3-27
	Off-Highway Vehicles	3-30
4.	COMBUSTION OF SOLID WASTES (Controlled and Uncontrolled)	4-1
	Open Burning	4-1
	Incineration	4-5
	Forest Fires and Agricultural Burning	4-13
5.	OTHER SOURCES	5-1
	Evaporative Loss Sources	5-1
	Fugitive Dust - Unpaved Roads	5-5
	Fugitive Dust - Paved Roads	5-9

TABLE OF CONTENTS (continued)

	Page
Fugitive Dust - Agricultural Tilling	5-13
Fugitive Dust - Construction	5-19

REFERENCES

APPENDICES*

* Appended in Volume II of this report.

LIST OF FIGURES

Figure		Page
1	Area Source Grid System for Metropolitan Atlanta	1-3
2	Particulate Emissions Density - 1973	1-6
3	SO_x Emission Density - 1973	1-7
4	CO Emission Density - 1973	1-8
5	HC Emission Density - 1973	1-9
6	NO_x Emission Density - 1973	1-10

LIST OF TABLES

Table		Page
1	Total Emissions from Fuel Usage by Source Category - 1973	vii
2	Total Emissions from Fuel Usage by Source Category - 1975	ix
3	Total Emissions from Fuel Usage by Source Category - 1980	xi
4	Total Emissions from Fuel Usage by Source Category - 1985	xiii
5	Source Category Descriptor Codes	xv
6	Data Accuracy of Source Categories	xviii
7	Grid Geographical Data - 1973	1-4
3-1	Traffic Count Data by County - 1973	3-4
3-2A	LTO Cycles by Airport	3-18
3-2B	Estimated Annual Emissions by Aircraft Category	3-19
3-3	Aircraft Emissions by Airport - 1973	3-20
3-4	Growth Data and Projected Emissions by Airport	3-23
3-5	Emission Factor Derivation - Off-Highway Vehicles	3-33
4-1	Structural Fires by County	4-2
4-2	List of Non-Point Source Incinerators by County - 1975	4-6
4-3	Classification of Incinerated Wastes	4-11
4-4	Forest/Grass/Field Fires by County - 1973	4-13
5-1	Fugitive Dust Emissions from Agricultural Fields Due to Wind Erosion - 1973	5-15
5-2	Total Emissions from Agricultural Tilling - 1973	5-16
5-3	Building Construction and Emissions in the Study Area	5-20

SUMMARY

This project was undertaken to prepare an inventory of area sources of air pollutant (particulate, SO_x, CO, HC, NO_x) emissions in five counties in metropolitan Atlanta (Fulton, Dekalb, Cobb, Clayton, Gwinnett) for use in analysis and modeling of air quality in this designated Air Quality Maintenance Area (AQMA) for the period 1975 to 1985. A base year of 1973 was specified for the inventory because this is the most recent year for which much of the published national, state, and local data were available.

The base year area source emissions are projected to three different future years--1975, 1980, and 1985--as part of this project. These analysis years are specified in the EPA regulations on preparation of AQMA plans.

The area source categories included in the inventory are shown in Tables 1, 2, 3, 4, with the category descriptor codes summarized in Table 5. This list of categories was compiled at the initial project meeting of the participants (EPA - Region IV, Georgia DNR, and PEDCo). It is conventional except for the four fugitive dust source categories.

Total pollutant emissions are summarized by category for the base year and three projection years in Tables 1, 2, 3, and 4. Survey data, emission estimating procedures, and projection techniques that were used to calculate these values for each source category are documented in detail in Chapters 1 through 5 of this report.

Table 1-1. TOTAL EMISSIONS FROM FUEL USAGE BY SOURCE CATEGORY - 1973 (ton/yr)

SOURCE CATEGORY	FUEL USAGE	INPUT UNITS	PARTICULATES	SULFUR OXIDES	CARBON MONOXIDE	HYDROCARBONS	NITROGEN OXIDES
RESIDFUL	6.24E+0	TON/YR	45.6	9.2	150.9	34.7	13.6
RESKERO	9.01E+0	10**3 GAL/YR	2.8.0	17.6	14.0	8.4	48.6
RESNGAS	4.26E+0	10**6 CU FT/YR	18.0	11.3	37.0	15.4	153.9
RESLPG	7.39E+0	10**3 GAL/YR	7.3	0.1	7.7	3.0	29.8
COMCOAL	1.26E+0	TON/YR	23.6.4	154.2	37.4	12.5	65.4
COMFUEL	1.13E+0	10**3 GAL/YR	591.0	7680.4	102.8	77.1	1541.6
COMKERO	9.03E+0	10**3 GAL/YR	36.6.1	151.3	97.6	73.2	1466.4
COMNGAS	1.09E+0	10**6 CU FT/YR	10.4.9	6.3	20.8	8.3.9	1259.0
COMLPG	3.42E+0	10**3 GAL/YR	31.7	0.2	33.4	12.9	157.1
INDCOAL	1.02E+0	TON/YR	2331.9	90.6.9	30.8	15.4	231.0
INDFUEL	0.0	10**3 GAL/YR	0.0	0.0	0.0	0.0	0.0
INDKERO	1.13E+0	10**3 GAL/YR	85.2	67.0.5	22.7	17.0	340.7
INDNGAS	2.53E+0	10**6 CU FT/YR	126.7	7.6	215.3	38.0	2216.6
INDLPG	2.38E+0	10**3 GAL/YR	1.8	0.0	1.6	0.3	12.2
WOOD	5.21E+0	TON/YR	44.3	0.0	130.4	10.4	5.2
GASMVEH	1.09E+0	10**6 VMT/YR	7395.5	1820.0	1050526.0	146183.0	57893.7
DIEMVEH	2.11E+0	10**6 VMT/YR	356.0	650.6	1998.4	534.5	5832.7
RAILROD	5.67E+0	10**3 GAL/YR	74.7	170.4	388.6	281.0	1105.9
VESSELS	8.37E+0	10**3 GAL/YR	0.0	2.7	1381.0	460.3	2.8
OFFHIWAY	6.04E+0	10**3 GAL/YR	495.4	658.5	23114.4	3360.5	6645.5
OPENBURN	1.71E+0	TON/YR	1431.0	17.1	5329.8	1319.6	257.1
FRACMFR	4.73E+0	TON/YR	402.3	0.0	2366.5	473.3	47.3
EVAPLOS	2.83E+0	TON/YR	0.0	0.0	0.0	19248.9	0.0
FRUMPRO	1.21E+0	10**3 VMT/YR	12349.1	0.0	0.0	0.0	0.0
EXPAVRD	1.12E+0	10**6 VMT/YR	15074.8	0.0	0.0	0.0	0.0

Table 1-1 (continued). TOTAL EMISSIONS FROM FUEL USAGE BY SOURCE CATEGORY - 1973 (ton/yr)

SOURCE CATEGORY	FUEL USAGE	INPUT UNITS	PARTICULATES	SULFUR OXIDES	CARBON MONOXIDE	HYDROCARBONS	NITROGEN OXIDES
AIRCRAFT	[illegible]631.0	LTO/YR	478.8	[illegible]5.0	19703.0	14180.8	2828.8
INCINERA	21758.0	TONS/YR	58.3	17.4	55.5	21.1	41.4
RESIDTL	4500.0	ACRES/YR	52.7	0.0	0.0	0.0	0.0
RESMNST	903.0	ACRES/YR	1264.3	0.0	0.0	0.0	0.0
RR/ESCRAN	21250.0	TONS/YR	180.0	0.0	1062.0	212.4	21.6
SUBTOTAL			28698				
FORAGE			15074.8				
TOTAL			43772.8	[illegible]52.2	1107355.6	186812.6	83536.9

Table 1-2. TOTAL EMISSIONS FROM FUEL USAGE BY SOURCE CATEGORY - 1975 (ton/yr)

SOURCE CATEGORY	FUEL USAGE	INPUT UNITS	PARTICULATES	SULFUR OXIDES	CARBON MONOXIDE	HYDROCARBONS	NITROGEN OXIDES
RESCOAL	4363.0	TON/YR	32.9	68.0	109.0	25.1	7.8
RESFUEL	9550.0	10**3 GAL/YR	27.8	171.8	13.9	8.3	33.3
RESNGAS	98725.0	10**6 CU FT/YR	193.6	11.6	387.3	154.9	1549.0
RESLPG	8488.0	10**3 GAL/YR	8.2	0.1	8.7	3.3	33.3
COMCOAL	13595.0	TON/YR	259.8	211.9	40.8	13.6	71.3
COMDIST	56013.0	10**3 GAL/YR	644.1	8371.1	112.0	84.0	1680.4
COMRESID	53236.0	10**3 GAL/YR	354.0	1046.7	106.4	79.8	1596.7
COMNGAS	20934.0	10**6 CU FT/YR	104.9	6.3	209.8	83.9	1259.0
COMLPG	37367.0	10**3 GAL/YR	34.6	0.3	36.4	14.0	214.9
INDCOAL	31875.0	TON/YR	2532.2	997.6	33.4	16.4	254.1
INDRESID	0.0	10**3 GAL/YR	0.0	0.0	0.0	0.0	0.0
INDDIST	12442.0	10**3 GAL/YR	93.7	737.0	25.0	18.7	374.8
INDNGAS	25332.0	10**6 CU FT/YR	126.7	7.6	215.3	38.0	2216.6
INDLPG	2297.0	10**3 GAL/YR	2.0	0.0	1.8	0.3	13.4
WOOD	3756.0	TON/YR	31.9	0.0	93.9	7.5	3.8
GASMVEH	11547.0	10**6 VMT/YR	7765.4	1911.0	957078.8	132767.4	50408.1
DIEMVEH	222.0	10**6 VMT/YR	374.5	684.5	2102.7	562.3	6136.7
RAILLOC	5978.0	10**3 GAL/YR	74.7	170.4	388.6	281.0	1105.9
VESSELS	862.0	10**3 GAL/YR	0.0	2.8	1422.3	474.1	2.8
OFHIVEH	62226.0	10**3 GAL/YR	513.3	678.3	23807.7	3461.3	6844.9
OPERHOR	161093.0	TON/YR	1345.1	16.1	5010.0	1240.4	241.6
FRAGHOR	45437.0	TON/YR	386.2	0.0	2271.8	454.4	45.4
EVAPLOS	3003554.0	TON/YR	0.0	0.0	0.0	20403.8	0.0
FDUNRD	10845.0	10**3 VMT/YR	11112.9	0.0	0.0	0.0	0.0
FDPAVED	11744.0	10**6 VMT/YR	15862.9	0.0	0.0	0.0	0.0

Table 1-2 (continued). TOTAL EMISSIONS FROM FUEL USAGE BY SOURCE CATEGORY - 1975 (ton/yr)

SOURCE CATEGORY	FUEL USAGE	INPUT UNITS	PARTICULATES	SULFUR OXIDES	CARBON MONOXIDE	HYDROCARBONS	NITROGEN OXIDES
[illegible]	844427.0	LT3/YR	491.9	574.9	20373.4	14601.2	2903.9
INCINERA	21754.0	T[illegible]S/YR	56.3	17.4	55.5	21.1	41.4
FEAST IL	4693.0	ACRES/YR	92.7	0.0	0.0	0.0	0.0
FOREST	473.0	ACRES/YR	1391.2	0.0	0.0	0.0	0.0
RF/AGRN	21166.0	T[illegible]S/YR	193.0	0.0	1058.4	208.8	21.6
SUBTOTAL			2234.5				
FUGITIVE			15962.9				
TOTAL			44087.4	16284.6	1014963.9	175027.7	87068.2

Table 1-3. TOTAL EMISSIONS FROM FUEL USAGE BY SOURCE CATEGORY - 1980 (ton/yr)

SOURCE CATEGORY	FUEL USAGE	INPUT UNITS	PARTICULATES	SULFUR OXIDES	CARBON MONOXIDE	HYDROCARBONS	NITROGEN OXIDES
RESCOAL	1957.0	TON/YR	14.8	30.5	48.9	11.3	9.4
RESOIL	5606.0	10**3 GAL/YR	28.0	173.5	14.0	8.4	33.6
RESNGAS	41367.0	10**6 CU FT/YR	206.8	12.4	413.6	165.4	1654.3
RESLPG	12063.0	10**3 GAL/YR	11.2	0.1	11.8	4.5	45.2
COMCOAL	17490.0	TON/YR	333.7	272.2	52.3	17.4	91.6
COMOIL	71443.0	10**3 GAL/YR	827.3	10751.9	143.9	107.9	2154.3
COMOIL	63338.0	10**3 GAL/YR	512.5	2115.1	136.7	102.5	2050.1
COMNGAS	23634.0	10**6 CU FT/YR	104.9	6.3	209.8	83.9	1259.0
COMLPG	4765.0	10**3 GAL/YR	44.4	0.3	46.8	18.0	276.0
INDCOAL	44345.0	TON/YR	3314.8	1306.0	44.3	22.2	332.6
INDOIL	0.0	10**3 GAL/YR	0.0	0.0	0.0	0.0	0.0
INDOIL	16353.0	10**3 GAL/YR	122.6	964.8	32.7	24.5	490.6
INDNGAS	25333.0	10**6 CU FT/YR	126.7	7.6	215.3	38.0	2216.6
INDLPG	3307.0	10**3 GAL/YR	2.6	0.0	2.3	0.5	17.6
WOOD	1654.0	TON/YR	14.2	0.0	41.7	3.3	1.7
GASMVEH	13966.0	10**6 VMT/YR	9392.1	2311.4	644160.8	94745.3	51834.8
DIEMVEH	269.0	10**6 VMT/YR	453.8	829.5	2547.8	681.4	7169.4
RAILLOC	5978.0	10**3 GAL/YR	74.7	170.4	388.6	281.0	1105.9
VESSELS	937.0	10**3 GAL/YR	0.0	3.0	1546.0	515.3	3.1
OFHIVEH	67604.0	10**3 GAL/YR	554.8	737.5	25888.2	3763.8	7443.0
OPENBUR	130246.0	TON/YR	1087.6	13.0	4050.6	1002.9	195.4
FRACBLR	41177.0	TON/YR	350.0	0.0	2058.8	411.8	41.2
EVAPLOS	35100388.0	TON/YR	0.0	0.0	0.0	23868.6	0.0
PCUNPRD	7859.0	10**3 VMT/YR	8026.4	0.0	0.0	0.0	0.0
PCPAVRD	14275.0	10**6 VMT/YR	19199.9	0.0	0.0	0.0	0.0

Table 1-3 (continued). TOTAL EMISSIONS FROM FUEL USAGE BY SOURCE CATEGORY - 1980 (ton/yr)

SOURCE CATEGORY	FUEL USAGE	INPUT UNITS	PARTICULATES	SULFUR OXIDES	CARBON MONOXIDE	HYDROCARBONS	NITROGEN OXIDES
AIRCRAFT	844539.0	LTO/YR	606.5	717.2	25375.0	18321.7	3630.9
[illegible]	21758.0	TONS/YR	58.3	17.4	55.5	21.1	41.4
[illegible]	4221.0	ACRES/YR	47.4	0.0	0.0	0.0	0.0
[illegible]	1241.0	ACRES/YR	1809.5	0.0	0.0	0.0	0.0
[illegible]	20133.0	TONS/YR	169.2	0.0	1004.4	201.6	21.6
SUBTOTAL			28294.8				
[illegible]			19199.9				
TOTAL			47494.7	20440.1	26434.9	144431.3	32118.3

Table 1-4. TOTAL EMISSIONS FROM FUEL USAGE BY SOURCE CATEGORY - 1985 (ton/yr)

SOURCE CATEGORY	FUEL USAGE	INPUT UNITS	PARTICULATES	SULFUR OXIDES	CARBON MONOXIDE	HYDROCARBONS	NITROGEN OXIDES
RESCOAL	884.0	TON/YR	6.7	13.8	22.1	5.1	2.0
RESFOIL	5662.0	10**3 GAL/YR	28.3	175.2	14.2	8.5	34.0
RESNGAS	44740.0	10**6 CU FT/YR	223.7	13.4	447.4	179.0	1789.6
RESLPG	16583.0	10**3 GAL/YR	15.7	0.1	16.6	6.4	63.7
COMCOAL	22186.0	TON/YR	424.3	346.1	66.6	22.2	116.5
COMFOIL	91471.0	10**3 GAL/YR	1051.9	13670.3	182.9	137.2	2744.1
COMDFOIL	66887.0	10**3 GAL/YR	651.7	2689.2	173.8	130.3	2606.6
COMNGAS	20944.0	10**6 CU FT/YR	104.9	6.3	209.8	83.9	1259.0
COMLPG	61022.0	10**3 GAL/YR	56.4	0.4	59.5	22.9	303.9
INDCOAL	53583.0	TON/YR	4005.3	1578.0	53.6	26.8	401.9
INDFOIL	0.0	10**3 GAL/YR	0.0	0.0	0.0	0.0	0.0
INDDFOIL	19759.0	10**3 GAL/YR	144.2	1165.8	39.5	29.6	592.8
INDNGAS	25333.0	10**6 CU FT/YR	126.7	7.6	215.3	38.0	2216.6
INDLPG	3633.0	10**3 GAL/YR	3.2	0.0	2.8	0.5	21.3
WOOD	730.0	TON/YR	6.2	0.0	18.3	1.5	0.7
GASMVEH	15286.0	10**6 VMT/YR	10279.8	2529.8	344103.0	46798.1	33163.0
DIEMVEH	293.0	10**6 VMT/YR	494.3	903.5	2775.1	742.2	8131.8
RAILLOC	5578.0	10**3 GAL/YR	74.7	170.4	388.6	281.0	1105.9
VESSELS	1030.0	10**3 GAL/YR	0.0	3.3	1699.5	566.5	3.4
OFHIVEH	74309.0	10**3 GAL/YR	609.3	810.0	28430.6	4133.4	8174.0
OFHNGUS	94257.0	TON/YR	787.0	9.4	2931.4	725.8	141.4
AGAGGUS	35024.0	TON/YR	297.7	0.0	1751.2	350.2	35.0
EVAPLOS	4104530.0	TON/YR	0.0	0.0	0.0	27910.9	0.0
PEDMPRO	4842.0	10**3 VMT/YR	4938.8	0.0	0.0	0.0	0.0
PEPAVED	15568.0	10**6 VMT/YR	20934.0	0.0	0.0	0.0	0.0

Table 1-4 (continued). TOTAL EMISSIONS FROM FUEL USAGE BY SOURCE CATEGORY - 1985 (ton/yr)

SOURCE CATEGORY	FUEL USAGE	INPUT UNITS	PARTICULATES	SULFUR OXIDES	CARBON MONOXIDE	HYDROCARBONS	NITROGEN OXIDES
AIRCRAFT	943752.0	LTO/YR	646.2	828.0	29407.4	21221.9	4191.9
INCINERA	21758.0	TONS/YR	98.1	17.4	55.5	21.1	41.4
FEAUTIL	3752.0	ACRES/YR	42.4	0.0	0.0	0.0	0.0
FPCONST	1607.0	ACRES/YR	2251.3	0.0	0.0	0.0	0.0
FF/AGMN	20813.0	TONS/YR	176.4	0.0	1029.6	205.2	21.6
SUBTOTAL			27559.4				
FORARD			20933				
TOTAL			48494.4	24938	414094.3	103648.1	67208.6

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Table 5. SOURCE CATEGORY DESCRIPTOR CODES

Code	Source category
RESCOAL	Residential coal
RESFOIL	Residential fuel oil
RESNGAS	Residential natural gas
RESLPG	Residential LPG
COMCOAL	Commercial-Institutional coal
COMROIL	Commercial-Institutional residual oil
COMDOIL	Commercial-Institutional distillate oil
COMNGAS	Commercial-Institutional natural gas
COMLPG	Commercial-Institutional LPG
INDCOAL	Industrial coal
INDROIL	Industrial residual oil
INDDOIL	Industrial distillate oil
INDNGAS	Industrial natural gas
INDLPG	Industrial LPG
WOOD	Residential wood
GASMVEH	Gasoline motor vehicles
DIEMVEH	Diesel motor vehicles
RAILLOC	Rail locomotive
VESSELS	Vessels
OFHIVEH	Off-highway vehicles
OPENBUR	Open burning
FFAGBUR	Forst fires and agricultural burning
EVAPLOS	Evaporative loss sources
FDUNPRD	Fugitive dust - unpaved roads
FDPAVRD	Fugitive dust - paved roads
AIRCRAFT	Aircraft
INCINERA	Incineration
FGDAGTIL	Fugitive dust - agricultural tilling
FGDCONST	Fugitive dust - construction
FFAGBATL	Forest fires and agricultural burning (City of Atlanta)

Area sources are a significant component of overall emissions in the AQMA and should have a major impact on air quality. It also appears that this impact may become proportionately larger in the future because emissions from most area source categories do not exhibit a downward trend in 1975 and beyond a point source emissions would be expected to exhibit.

A source category not originally intended for inclusion herein, but which is received increased attention, is fugitive dust from paved roads. An accurate quantification of the contribution from this source was difficult. It has, however, been evaluated for its estimated impact on air quality and is discussed as an additional fugitive dust source in Chapter 5. Summary Tables 1, 2, 3, 4 include this other area source emissions.

The procedures used to allocate emissions for each area source category to the grid cells are also explained in detail in subsequent sections. The resulting total emissions by grid for 1973, 1975, and 1980, and 1985 are presented in the Appendices (appended in Volume II). This data can be used directly in the AQMA modeling effort for air quality in the Atlanta region.

The accuracy of the data used in compiling this ares source inventory has been estimated based upon the level of accuracy and reliability of the contacts made and sources used.

Table 6 shows PEDCo's assessment of the accuracy (Order 3, highest accuracy) of data used in computing the area-wide emissions, projections, and subarea distribution for each source category. PEDCo has attempted to use the best available data and methods in compiling this area source emission inventory for the Atlanta region.

Table 6. DATA ACCURACY* OF SOURCE CATEGORIES

Chapter	Source category	Area-wide emissions	Projections	Subarea distribution
2	Bituminous coal			
	Residential coal	1	2	3
	Commercial coal	2	2	3
	Industrial coal	2	2	3
2	Fuel oil			
	Residential fuel oil	1	2	3
	Commercial dist. oil	2	2	3
	Industrial dist. oil	2	2	3
	Commercial resid. oil	2	2	3
	Industrial resid. oil	2	-	-
2	Natural gas			
	Residential nat. gas	2	3	3
	Commercial nat. gas	2	3	3
	Industrial nat. gas	2	3	3
2	LPG			
	Residential LPG	2	1	3
	Commercial LPG	2	2	3
	Industrial LPG	2	2	3
2	Wood	1	1	3
3	Gasoline motor vehicles	3	3	3
3	Diesel motor vehicles	3	3	3
3	Aircraft	2	2	3
3	Rail locomotive	2	2	3
3	Vessels	2	1	3
3	Off-highway vehicles	1	1	1
4	Open burning	2	1	1
4	Incineration	3	2	3
4	Forest fires & agricultural burning	3	1	2

Table 6 (continued). DATA ACCURACY* OF SOURCE CATEGORIES

Chapter	Source category	Area-wide emissions	Projections	Subarea distribution
5	Evaporative loss sources	1	1	1
5	Fugitive dust - unpaved roads	2	2	2
5	Fugitive dust - paved roads	1	1	1
5	Fugitive dust - agricultural tilling	3	2	2
5	Fugitive dust - construction	3	2	1

*Order 1 least detail and accuracy
2 moderate detail and accuracy
3 most detail and accuracy

1. GENERAL METHODOLOGY

The following describes the data, references, assumptions, and calculations used to estimate area source pollutant emissions for each of the 30 categories in the inventory. A separate subsection is provided for each source category. For each source category, the text is divided into three parts:

1. estimating area-wide base year emissions,
2. projecting base year emissions to the three future years,
3. allocating emissions to subarea grid cells.

Difficulties were experienced in attempting to project fuel usage, particularly fuel oil and natural gas, because of the many uncertainties at this time surrounding the future availabilities and costs of alternate fuels in the Atlanta area. The intermediate-term impacts of energy conservation programs and the current economic recession further clouded the data available for making assumptions and projections. Overall, the increase in total energy consumption represented by the fuel usage increases shown in this report have been estimated in order to, insofar as possible, keep pace with the population and industrial-commercial growth expected in the Metropolitan area, and maintain a "worst case" analysis. However, expected reductions in per capita consumption of energy may account for future differences.

In order to input area source emissions into the atmospheric dispersion model for AQMA analysis, the distribution of

these emissions within the study area must be determined. This was accomplished by allocating the total emissions for each category into grid squares covering the entire area, as shown in Figure 1. Four grid sizes are used: 2-1/2, 5, 10, and 20 km. This grid system is essentially the same as the one used in the previous inventory, except that some of the original grids are subdivided to give better resolution in the urban fringe areas where growth and development are expected to cause the most extreme changes in emission rates during the 1973 to 1985 period. The new grid system has 93 grids, and Table 7 summarizes the geographical data pertinent to each.

The "Area-2 Program," originally developed by EPA, was employed to enable rapid, accurate calculation and allocation of emissions. Required input data are fuel usage totals, emission factors, and pertinent grid information. The program was modified by PEDCo to accept data input from up to 25 source categories requiring emission calculation and apportioning and 10 categories which are best treated as "point sources." Additionally, the data output now assumes a completely versatile and informative format, suitable for direct inclusion in this report.

Finally, Figures 2 through 6 depict the emission densities in tons/km^2-day over the Atlanta Metropolitan area in 1973.

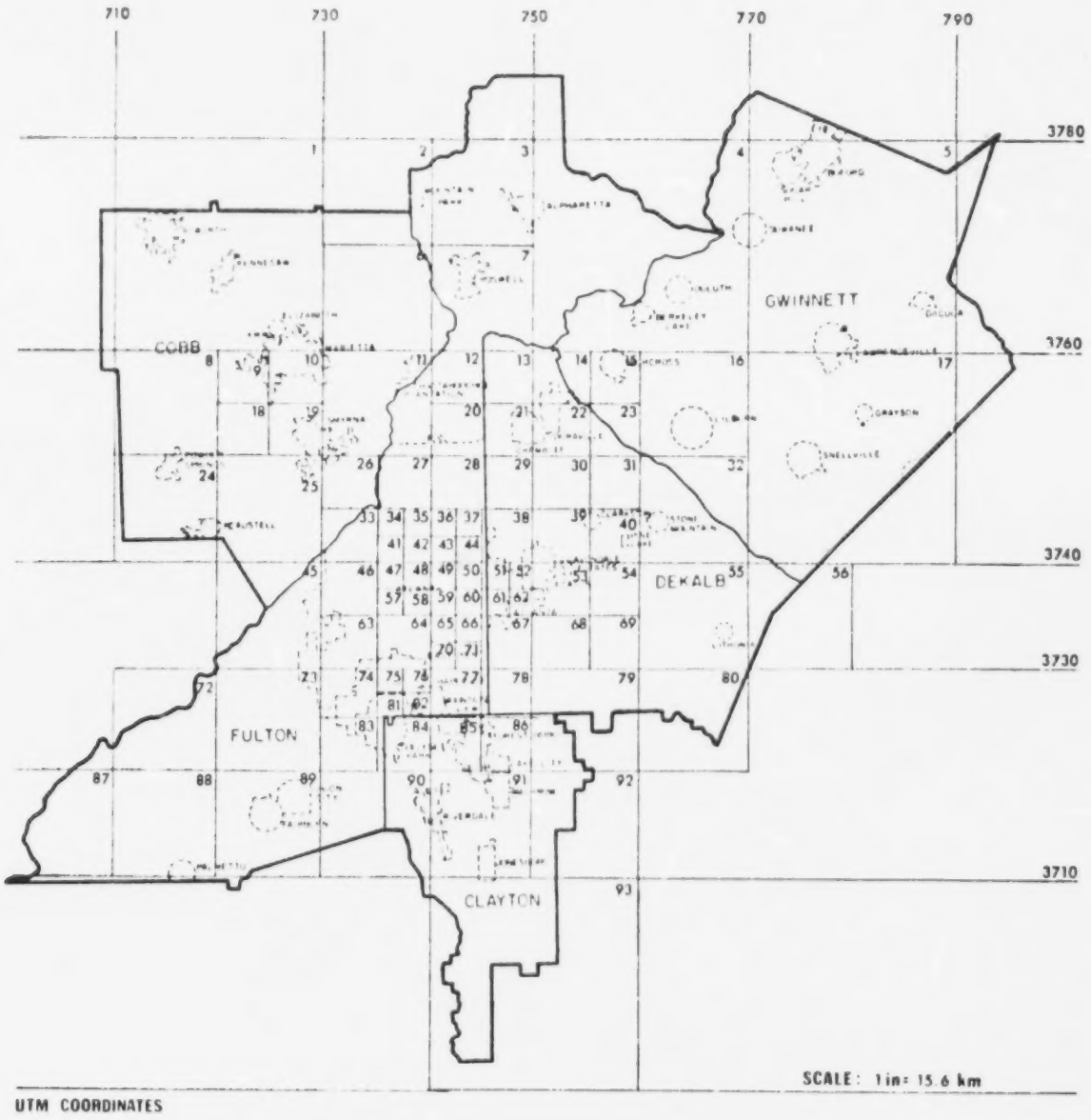

Figure 1. Area source grid system for Metropolitan Atlanta.

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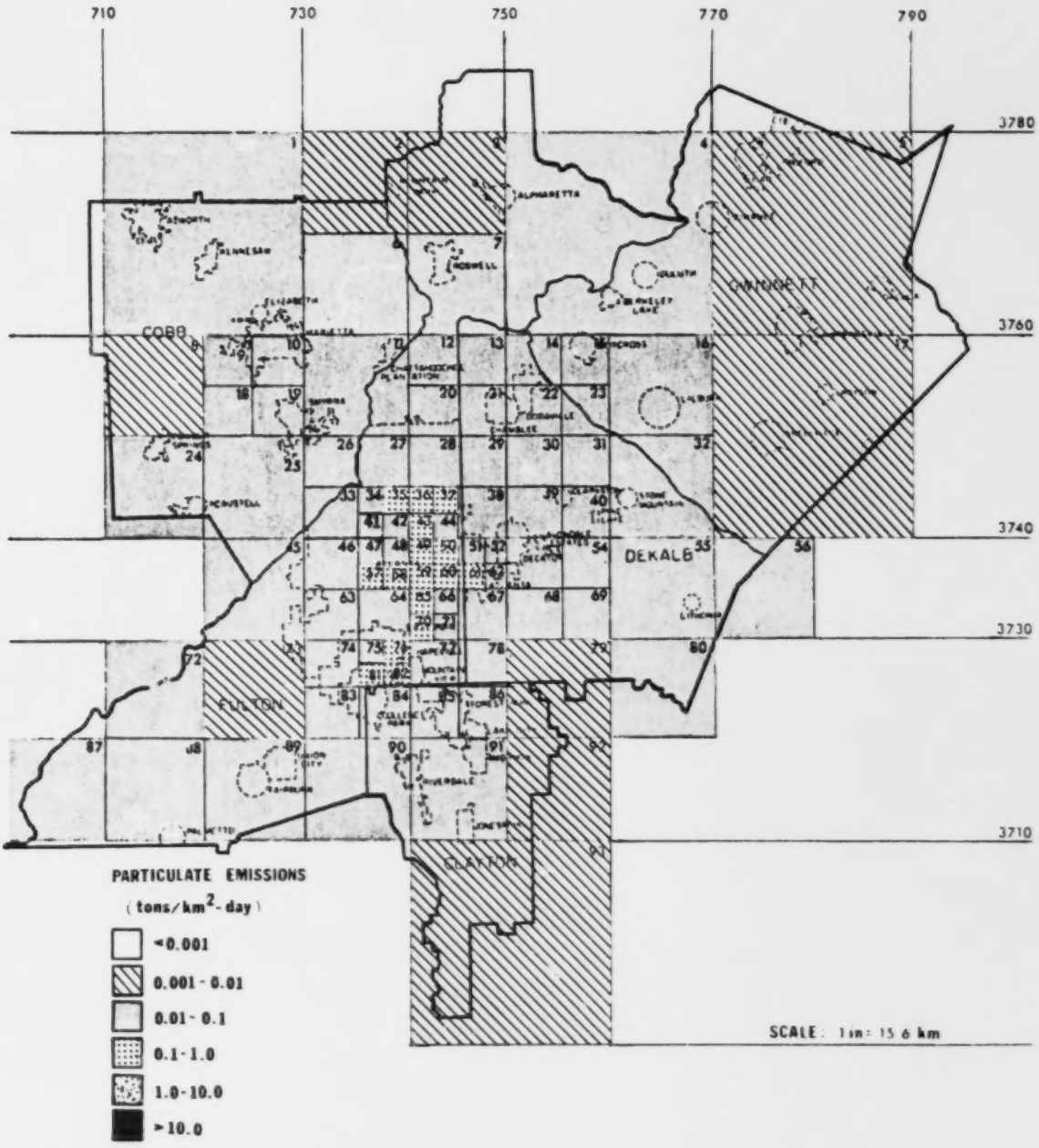

Figure 2. Particulate Emission Density - 1973

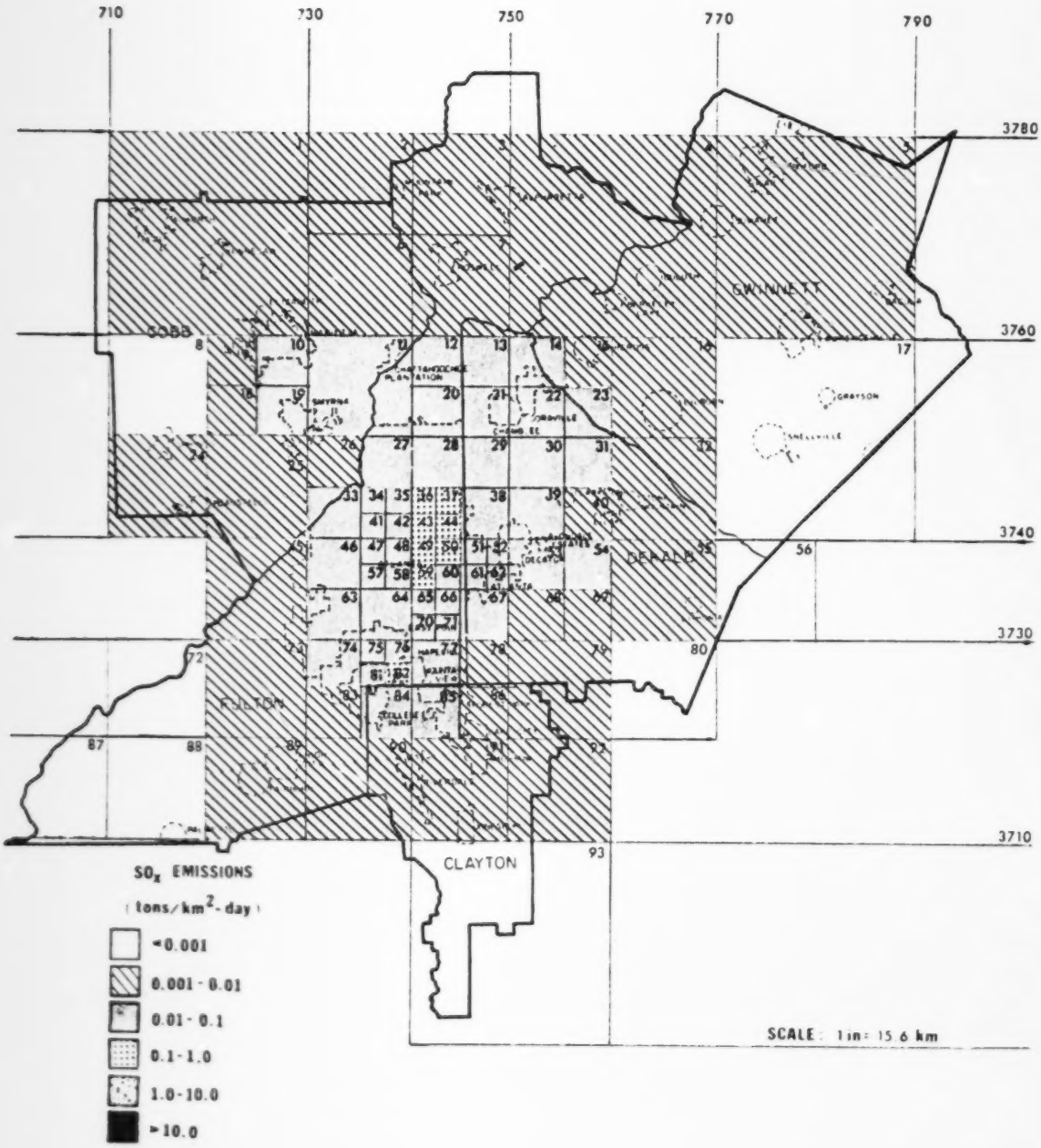

Figure 3. SO_x Emission Density - 1973

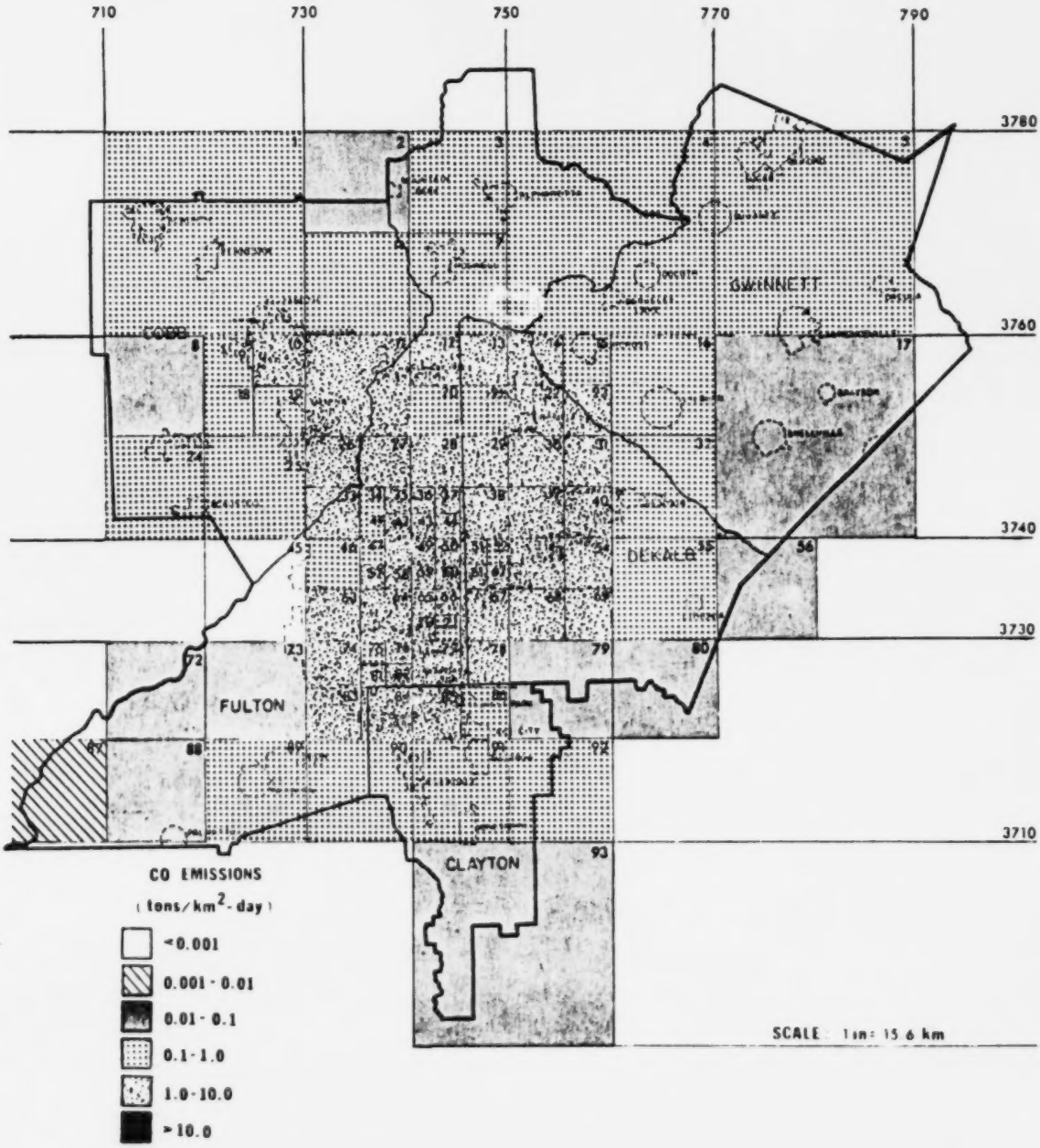

Figure 4. CO Emission Density - 1973

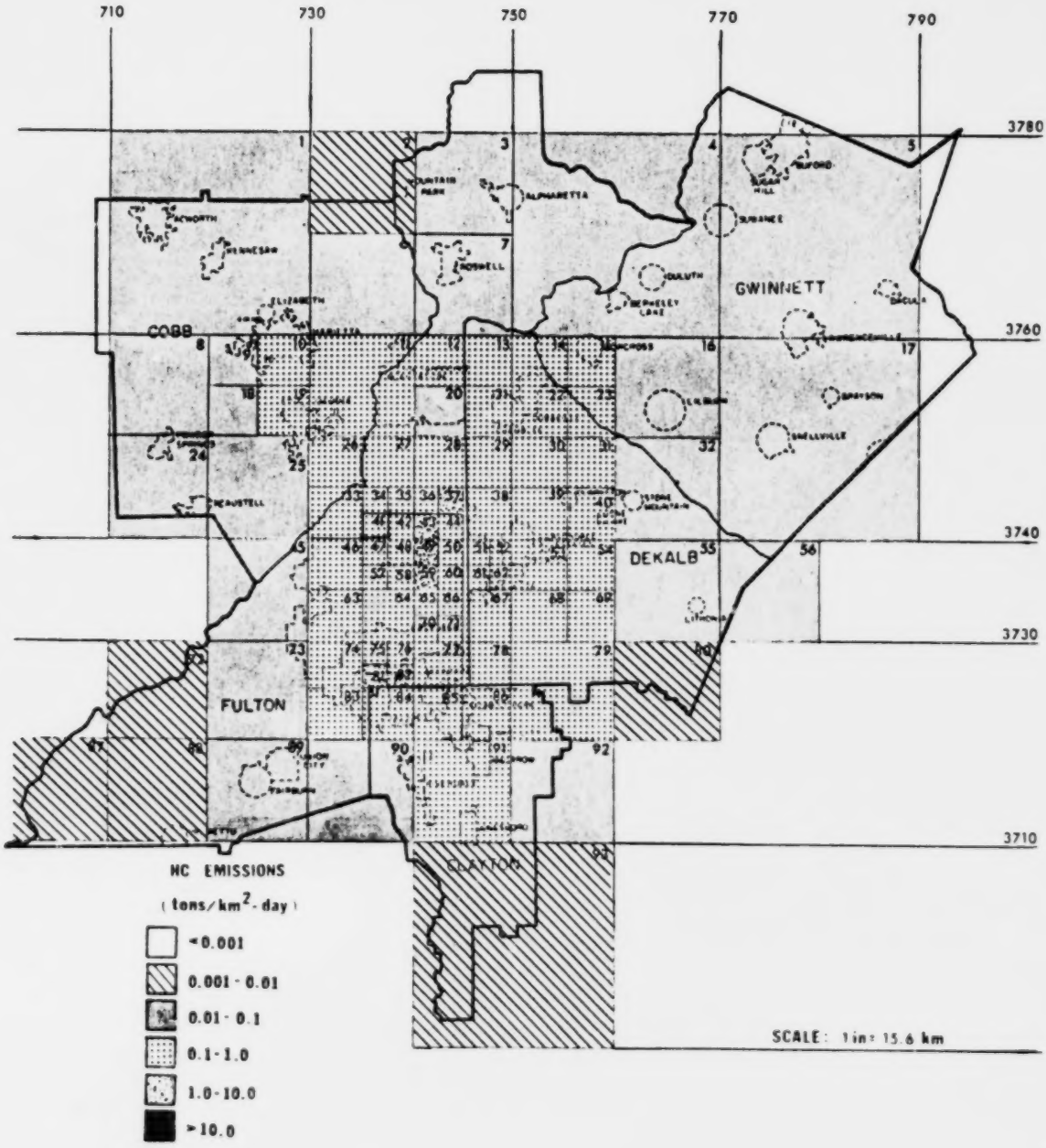

Figure 5. HC Emission Density - 1973

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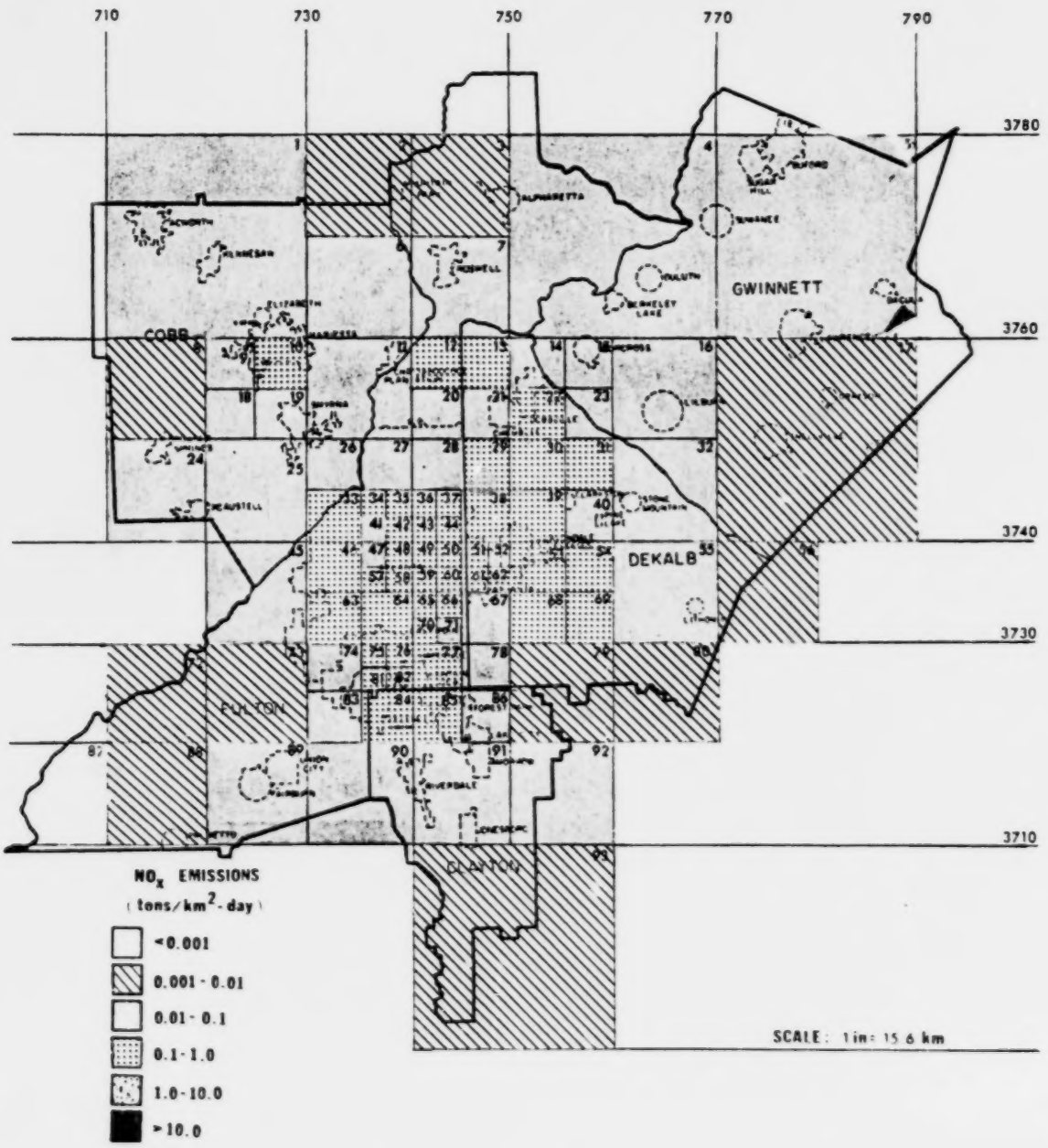

Figure 6. NO_x Emission Density - 1973

2.0 STATIONARY SOURCE FUEL COMBUSTION

BITUMINOUS COAL

Area-wide Emissions

An effort was made to determine coal consumption in the five-county area through contacts with the local coal distributors. Of the companies contacted, only a few were able to provide what they felt was complete and reliably accurate data. Many were unable to provide the data requested because their sales figures were not computed in coincidence with the geographic boundaries of this study. Some were unwilling to cooperate in providing the requested information.

The methods used to compute coal consumption involved following the procedures outlined in APTD-1135 (Ref. 1).

Residential (RESCOAL):

Residential coal consumption was calculated by the "degree day method," computed as follows:

$$\text{Area total} = (\text{Dwelling units using coal})(\text{Heating requirement factor})(\text{No. degree days/yr})\left(\frac{\text{Rooms/dwelling unit - study year}}{\text{5 avg. room/dwelling unit - U.S.}}\right)$$

The calculations are summarized by county for 1973:

County	Dwelling units using coal	x	Heating requirement factor[a]	x	Degree days[b] per year	x	Rooms / D.U.	$(\frac{1}{5})$	=	Coal usage (tons/year)
Fulton	884		.0012		2,999		$\frac{4.8}{5}$			3,054.1
Dekalb	113		.0012		2,999		$\frac{5.6}{5}$			455.5
Cobb	357		.0012		2,999		$\frac{5.3}{5}$			1,361.9
Clayton	26		.0012		2,999		$\frac{5.2}{5}$			97.3
Gwinnett	280		.0012		2,999		$\frac{5.3}{5}$			1,068.1
Totals	1,660									6,037
References	2, 3		1		4		2			

[a] (tons coal/dwelling unit - degree day)

[b] (the sum of the negative departures of average daily temperature from 65°F)

The total study area residential coal consumption is then, 6,037 tons/year in 1973.

Commercial-Institutional (COMCOAL):

To obtain commercial-institutional coal consumption, the total state residential consumption must be calculated and subtracted from the total state consumption, the result then apportioned to the five-county region.

Total state dwelling units using coal in 1970 = 24,754 (Ref. 2)

Total state dwelling units using coal in 1960 = 102,626 (Ref. 3)

Figure an exponential extrapolation ($S=Pe^{nr}$) to 1973, where, $r = \frac{\ell n\ S/P}{n}$ = -14.22% usage decrease/year.

Therefore,
Total estimated state dwelling units using coal in 1973 = 16,157

Average annual heating degree days (average of Atlanta-2999, Savannah-1597, Albany-1987) = 2,194 (Ref. 4)

Total state residential coal consumption = $(16,157)(2,194)(.0012)(\frac{5}{5})$
= 42,538 tons/year

Then,
State retail dealer's sales = 72,000 tons/year (Ref. 5)[a]
less -

[a]One hundred percent of the GA/FLA total apportioned to GA based on data provided by the Bureau of Mines: In 1974, GA sales = 63.2% of the total and 100% of the "retail dealers" and "all other" categories. It has been assumed that this same distribution prevailed in 1973, when separate GA/FLA sales figures were not calculated (Ref. 6).

State residential consumption = (-)42,538 tons/year

Total state commercial - institutional coal usage = 29,462 tons/year

less-

State commercial-institutional point source coal usage = (-) 3,208 tons/year (Ref. 7, Table C-1)

Total state commercial-institutional area source coal consumption = 26,254 tons/year

Apportioning to the study area by number of commercial/institutional/government employees: (Refs. 8, 9)

Total 5-county commercial-institutional area source coal consumption = $(26,254)(\frac{468,004}{985,800})$

= 12,464 tons/year

Industrial (INDCOAL):

Total (GA and FLA) "all other" bituminous coal sales - 1973 = 388,000 tons/year (Ref. 5)

GA coal usage = 388,000 tons/year (Ref. 6)

less, GA state industrial point source coal usage = (-)261,765 tons/year (Ref. 7 Table C-1)

Total state industrial bituminous coal area source usage = 126,235 tons/year

Apportioning to the study area by number of manufacturing employees (it was assumed that the ratio -

$\frac{\text{study area mfg. employees}}{\text{state mfg. employees}}$

of the 1970 data used was the same as the 1973 ratio), (Ref. 10):

Total 5-county industrial bituminous coal area source consumption = $(126,235)(\frac{115,905}{475,121})$

= 30,795 tons/year

The total area source bituminous coal consumption for the 5-county region is the sum of the RESCOAL, COMCOAL and INDCOAL categories: 6,037 + 12,464 + 30,795 = 49,296 tons/year.

Emission factors for the three categories were derived from AP-42 (Ref. 11) and are summarized by source category in Appendix A. Fuel sulfur and ash content were estimated from the average of those categories in the Georgia State SCC Point Source listing (Appendix C).*

Total emissions from these categories in 1973 are presented below and in Table 1.

Source category	Total emissions (tons/year) - 1973				
	Partic.	SO_x	CO	HC	NO_x
RESCOAL	45.6	94.2	150.9	34.7	13.6
COMCOAL	238.4	194.2	37.4	12.5	65.4
INDCOAL	2301.9	906.9	30.8	15.4	231.0
Totals	2585.9	1195.3	219.1	62.6	310.0

Projections

Residential coal usage is steadily declining due to home heating conversions to natural gas and electricity. New homes that use coal as a heating fuel are not being built. Also, coal heated buildings are often quite old and subject to demolition in urban renewal and highway projects. Projections, therefore, were based upon the estimated number of dwelling units using coal in the projections years, derived by the exponential extrapolation method previously described.

* Residential & Commercial A 5.1% S .82%
  Industrial A 11.5% S 1.55%

In arriving at these values, it was assumed that the number of houses using coal would continue to decline at the same rate/year as was consistent with the 1960-1970 trend, (Appendix B).

Year	1973	1975	1980	1985
No. houses using coal	1,660	1,199	538	243
Growth factor	base	0.72	0.32	0.15
RESCOAL consumption (tons/year)	6,037	4,360	1,957	884

RESCOAL emissions for the projection years are presented in Tables 2, 3, 4, assuming that the same emission factors and fuel sulfur and ash contents prevail as in 1973.

Commercial-institutional coal usage in the future was assumed to reflect the economic climate projected for the Atlanta air quality control region.

Atlanta Regional Commission data was available to indicate the projected growth for the 5-county region based on future estimates of the number of commercial/institutional/government employees. However, factors derived from these data were not employed due to their nonlinear variation with economic indicators and level of commercial activity. U.S. Department of Commerce, Bureau of Economic Analysis (BEA) growth projections (Ref. 12) are presented as the best available projection data at this time. Projected emissions are presented in COMCOAL category, Tables 2, 3, 4.

Year	1973	1975	1980	1985
Atlanta AQCR earnings for wholesale and retail trade, services, and government categories (10^3 1967 $).	(interpolated) 3,125,592	3,420,600	4,362,300	5,557,700
Growth factor	base	1.09	1.40	1.78
COMCOAL usage (tons/year)	12,464	13,586	17,450	22,186

Industrial area source coal consumption, in consonance with commercial-institutional usage, will most probably increase in the future due to the expected continuance of critical supply shortages and higher costs of cleaner burning fuels. In the absence of detailed statistics revealing projected energy market demands, industrial growth has been estimated based on the BEA projections for all manufacturing industries (Ref. 12).

Year	1973	1975	1980	1985
Atlanta AQCR Mfg. earnings (10^3 1967 $)	(inter-polated) 1,429,884	1,577,000	2,055,000	2,490,800
Growth factor	base	1.10	1.44	1.74
INDCOAL usage (tons/year)	30,795	33,875	44,345	53,583

INDCOAL emissions for the three future years are presented in Tables 2, 3, 4.

Subarea Distribution

Apportioning of pollutant emissions from the 5-county area source bituminous coal combustion to grid cells was based on the following factors for each source category:

RESCOAL - No. houses in each grid using coal (Refs. 2, 3)
COMCOAL - No. commercial/institutional/government employees in each grid (Ref. 8)
INDCOAL - No. manufacturing employees in each grid (Ref. 8)

Allocated emissions for these categories for all study years are presented in Appendices D through O.*

* Apportioning factors by grid are found in Tables Q-1 to Q-4.

FUEL OIL - DISTILLATE

Area-wide Emissions

A survey of several retail fuel oil dealers in the Atlanta region yielded much the same vague data as determined from contacts with local coal distributors. Since there are approximately 25 fuel oil dealers, the lack of data from any one of which would render the total fuel oil sales total invalid, this method of computation of fuel oil sales was discontinued.

Residential (RESFOIL):

Consumption of distillate fuel oil in the 5-county region was calculated by the degree-day method previously described for coal.

The calculations are summarized by county for 1973:

County	Dwelling units using oil	x	Heating requirement factor[a]	x	Degree days per year	x	$\frac{\text{Rooms}}{\text{D.U.}}(\frac{1}{5})$	= Oil usage (10^3 gal/year)
Fulton	4,126		0.18		2,999		$\frac{4.8}{5}$	2,138.2
Dekalb	1,213		0.18		2,999		$\frac{5.6}{5}$	733.4
Cobb	2,390		0.18		2,999		$\frac{5.3}{5}$	1,367.6
Clayton	883		0.18		2,999		$\frac{5.2}{5}$	495.7
Gwinnett	1,522		0.18		2,999		$\frac{5.3}{5}$	870.9
Totals	10,134							5,606
References	2, 3		1		4		2	

[a] (gal.oil/dwelling unit-degree day).

The total 5-county area source residential distillate oil consumption is $5,606 \times 10^3$ gal/year in 1973.

Commercial-Institutional (COMDOIL):

To obtain the commercial-institutional area source distillate oil usage, the following state data were used:

Kerosene used for heating	=	121×10^3 bbl	(Ref. 13)
Distillate type heating oils	=	$2,984 \times 10^3$ bbl	(Ref. 13)
Distillate used by military	=	95×10^3 bbl	(Ref. 13)
Total		$3,200 \times 10^3$ bbl	
		$\times$ 42 gal/bbl	

Total state commercial-institutional and residential distillate oil consumption $= 134,400 \times 10^3$ gal

The state residential distillate oil usage must be subtracted from the above,

Total state dwelling units using distillate oil in 1970	=	67,956	(Ref. 2)
Total state dwelling units using distillate oil in 1960	=	106,117	(Ref. 3)

Using an exponential extrapolation ($S = Pe^{nr}$) to 1973, where $r = \frac{\ell n\ S/P}{n}$ = (-)4.45% usage decrease/year.

Therefore,

Total estimated state dwelling units using distillate oil in 1973	=	59,451
Average annual heating degree-days (Avg. of Atlanta, Savannah, Albany)	=	2,194 (Ref. 4)

Total state residential distillate oil consumption $= (59,451)(2,194)(0.18)(\frac{5}{5})$

$= 23,478 \times 10^3$ gal

Then, $134{,}400 \times 10^3$ gal

(-) $23{,}478 \times 10^3$ gal

Total state commercial-institutional distillate oil usage = $110{,}922 \times 10^3$ gal

less, Total state commercial-institutional point source distillate oil usage = (-)$8{,}102 \times 10^3$ gal (Ref. 7, Table C-1)

Total state commercial-institutional area source distillate oil usage = $102{,}820 \times 10^3$ gal

Apportioning to the 5-counties by number of commercial/institutional/government employees, (Refs. 8, 9)

Total 5-county commercial-institutional area source distillate oil consumption = $(102{,}820)\left(\frac{468{,}004}{985{,}800}\right)$

= $\underline{48{,}813 \times 10^3 \text{ gal/year}}$

Industrial (INDDOIL):

Industrial consumption of distillate oil was determined using the following state data from Reference 13:

State industrial distillate oil sales = $1{,}584 \times 10^3$ bbl

State sales to oil companies = $\underline{56 \times 10^3 \text{ bbl}}$

$1{,}640 \times 10^3$ bbl

$\underline{\times 42 \text{ gal/bbl}}$

Total state industrial distillate oil usage = $68{,}880 \times 10^3$ gal

Subtracting the industrial point source usage of 22,331 x 10^3 gallons/year (Ref. 7, Table C-1) from this amount gives an industrial area source distillate oil consumption of 46,549 x 10^3 gallons/year in the state. This total, when apportioned to the study area by number of manufacturing employees (applying the same assumptions as for coal) equals, (Ref. 10)

Total study area industrial area source distillate oil usage $= (46,549 \times 10^3)(\frac{115,905}{475,121})$

$= 11,356 \times 10^3$ gal/yr

The total area source distillate oil consumption for the 5-county region is,

Residential	$5,606 \times 10^3$ gal/year
Commercial-institutional	$48,813 \times 10^3$ gal/year
Industrial	$11,356 \times 10^3$ gal/year
Total distillate oil consumption	$65,775 \times 10^3$ gal/year

Emission factors derived from AP-42 were applied to the fuel totals to calculate emission totals summarized in Table A-1 (Appendix A). Fuel sulfur (Distillate: Res. & Comm S.43% Industrial S.82%; Residual: Res. & Comm. S 1.88%, Industrial S 2.04%) contents estimated from the SCC point source printout, Table C-1 (Appendix C).

The 5-county area source pollutant emissions resulting from combustion of distillate oil are:

Source category	Total emissions (tons/year) - 1973				
	Partic.	SO_x	CO	HC	NO_x
RESFOIL	28.0	173.6	14.0	8.4	33.6
COMDOIL	366.1	1511.3	97.6	73.2	1464.4
INDDOIL	85.2	670.5	22.7	17.0	340.7
Totals	479.3	2355.4	134.3	98.6	1838.7

Projections

Distillate fuel oil consumption by the residential sector for the future study years was based on the estimated number of dwelling units using fuel oil for heating. In determining these estimates, it was assumed that the counties' usage rate through 1985 was consistent with the 1960-1970 trend (Appendix B). As was expected, residential usage remains relatively level over the period.

Year	1973	1975	1980	1985
No. houses using fuel oil	10,134	10,119	10,150	10,267
Growth factor	base	0.99	1.00	1.01
Fuel oil consumption (10^3 gal/year)	5,606	5,550	5,606	5,662

Future RESFOIL pollutant emissions are presented in Tables 2, 3, 4, assuming that the same emission factors and fuel sulfur and ash contents prevail as in 1973.

The majority of emissions from this category will result from the commercial-institutional and industrial sectors where increased fuel oil usage is entirely probable, since natural gas in the Atlanta region will be restricted to these users (Ref. 14). For this reason, BEA (Ref. 12) commercial-institutional growth projections were used to estimate commercial-institutional fuel use for the study years. Projected emissions are tabulated in COMDOIL category, Tables 2, 3, 4.

Year	1973	1975	1980	1985
Atlanta AQCR earnings for wholesale & retail trade, services, and government categories (10^3 1967 $).	(interpolated) 3,125,592	3,420,600	4,362,300	5,557,700
Growth factor	base	1.09	1.40	1.78
COMDOIL usage (10^3 gal/year)	48,813	53,206	68,338	86,887

Industrial growth has been estimated based on the BEA projections for all manufacturing industries (Ref. 12):

Year	1973	1975	1980	1985
Atlanta AQCR mfg. earnings (10^3 1967 $)	(interpolated) 1,429,884	1,577,000	2,055,000	2,490,800
Growth factor	base	1.10	1.44	1.74
INDDOIL usage (10^3 gal/yr)	11,356	12,492	16,353	19,759

INDDOIL projected emissions are tabulated in Tables 2, 3, 4.

Subarea Distribution

Pollutant emissions resulting from area source distillate fuel oil combustion were distributed to all grid cells based upon:

RESFOIL = No. houses in each grid using fuel oil (Refs. 2, 3)
COMDOIL = No. commercial/institutional/government employees in each grid (Ref. 8)
INDDOIL = No. manufacturing employees in each grid (Ref. 8)

Computer allocated emissions are tabulated in Appendices D through P.

FUEL OIL - RESIDUAL

Area-wide Emissions

Data for total state consumption of residual fuel oil were obtained from Bureau of Mines data (Ref. 13) and the computation methods described in Reference 1 were followed.

Residential:

Contact with several major local fuel oil distributors indicated that there was no residential usage of residual oil in the Atlanta Region.

Commercial-Insitutional:

The total state consumption of residual fuel oil in 1973 for the commercial-institutional sector is the combination of:

Residual type heating oils	=	$2,492 \times 10^3$ bbl	(Ref. 13)
Residual used by military	=	100×10^3 bbl	(Ref. 13)
		$2,592 \times 10^3$ bbl	
Total state commercial-institutional residual oil consumption	=	x 42 gal/bbl $108,864 \times 10^3$ gal	

Subtracting the state commercial-institutional point source usage of 620×10^3 gal/yr (Table C-1) from this total gives the commercial-institutional area source residual oil consumption of $108,244 \times 10^3$ gal/year in the state.

The total fuel usage when apportioned to the study area by number of commercial/institutional/government employees equals; (Refs. 8,9)

Total 5-county commercial-institutional area source residual oil consumption = $(108{,}244 \times 10^3)\ (\frac{468{,}004}{985{,}800})$

= $51{,}388 \times 10^3$ gallons/year

Industrial:

The state industrial residual oil consumption in 1973 is a combination of:

State industrial residual oil sales = $7{,}114 \times 10^3$ bbl (Ref. 13)

State oil company sales = 152×10^3 bbl

$7{,}266 \times 10^3$ bbl

Total state industrial residual oil usage = x 42 gal/bbl

= $305{,}172 \times 10^3$ gal/year

Subtracting the state industrial point source usage of $324{,}786 \times 10^3$ gal/yr (Table C-1) from this amount gives a state area source residual oil consumption of (-) $19{,}614 \times 10^3$ gal. Therefore, it is concluded that there is no industrial area source combustion of residual oil in the 5-county region, in agreement with the findings of GA. DNR in their treatment of 1972 data.

The total area source residual oil consumption for the study area is the commercial-institutional total - $51{,}388 \times 10^3$ gal/year.

Emission factors were determined from AP-42 as in preceeding sections (Table A-1).

The 5-county area source pollutant emissions resulting from combustion of residual oil are:

Source category	Total emissions (tons/year) - 1973				
	Partic.	SO_x	CO	HC	NO_x
COMROIL	591.0	7680.4	102.8	77.1	1541.6

Projections

As with distillate fuel oil, projections for future residual oil usage in the commercial-institutional sector were derived from the BEA data (Ref. 12). Growth factors were determined from categories listed as wholesale and retail trade, services, and government employment and are shown below with projected fuel usage for each study year. Corresponding projected emissions are presented in Tables 2, 3, 4.

Year	1973	1975	1980	1985
Atlanta AQCR earnings for wholesale & retail trade, services, and government categories (10^3 1967 $).	(interpolated) 3,125,592	3,420,600	4,362,300	5,557,700
Growth factor	base	1.09	1.40	1.78
COMROIL usage (10^3 gal/year)	51,388	56,013	71,943	91,471

Subarea Distribution

Allocation of total emissions mirrored the methodology applied for the COMDOIL category. Grid emissions are tabulated in Appendices D through P.

NATURAL GAS

Area-Wide Emissions

The consumption of natural gas in the study area would generally be best determined by contact with the natural gas distributor. Atlanta Gas Light's total sales in metropolitan Atlanta in 1973 (Ref. 14) were:

Residential	=	$44{,}000 \times 10^6$ ft^3
Commercial	=	$23{,}000 \times 10^6$ ft^3
Industrial	=	$45{,}000 \times 10^6$ ft^3
Public Authority	=	$1{,}000 \times 10^6$ ft^3

These figures, however, reflect the distribution to the entire metropolitan Atlanta distribution district; a specific breakdown for the counties in the study area was not available. Therefore, this data was not used in succeeding computations.

Another method used to determine the natural gas usage involves following the procedure outlined in Reference 1 and use of the following data:

Residential (RESNGAS):

Total 5 county dwelling units using natural gas	= 399,597 in 1973	(Ref. 2,3 Table B-1)
Total state dwelling units using natural gas With exponential extrapolation (r = +4.16%/yr)	= 533,435 (1960)/ 808,597 (1970) = 916,007 in 1973	(Ref 2,3 Table B-1)
Total state residential natural gas consumption	= $86{,}191 \times 10^6$ ft^3	(Ref. 15)

The total residential natural gas consumption in the study area is obtained by apportioning the total state consumption by the number of dwelling units using natural gas.

Total 5 county residential = $(86, 191 \times 10^6) \left(\frac{399,597}{916,077}\right)$

natural gas consumption = $37,597 \times 10^6$ ft^3/year

An alternate computation to arrive at residential consumption involved employing the degree-day method described in preceeding sections. The computations are summarized by county for 1973:

County	Dwelling units using N. gas	×	Heating requirement factor[1]	×	Degree days per year	×	Rooms / D.U.	1/5	=	N. gas usage (10^6 ft^3/year)
Fulton	175,479		22.5		2,999		4.8	5		11,367.2
Dekalb	124,259		22.5		2,999		5.6	5		9,390.8
Cobb	56,511		22.5		2,999		5.3	5		4,042.0
Clayton	25,899		22.5		2,999		5.2	5		1,817.5
Gwinnett	17,449		22.5		2,999		5.3	5		1,248.1
Totals	399,597									27,866
References	2, 3		1		4		2			

[a] (ft^3 N. gas/dwelling unit-degree day)

The total residential natural gas consumption computed by this method is 27,866 x 10^6 ft^3/year, 75% of the value computed using state data. Though inaccuracies are inherent with both methods of computation, it was decided to use the BOM calculation (37,597 x 10^6 ft^3/year) for further analysis.

Commercial-Institutional (COMNGAS):

To obtain commercial-institutional fuel consumption,

State commercial sales = 43,663 x 10^6 ft^3 (Ref. 15)

State other consumers = 3,590 x 10^6 ft^3 (Ref. 15)

Total state commercial-institutional natural gas consumption = $47,253 \times 10^6 ft^3$/year

Subtracting the state commercial-institutional point source usage of $3,052 \times 10^6$ ft^3 (Ref. 7 Table C-1), the state area source commercial-institutional consumption is equal to $44,201 \times 10^6$ ft^3/year.

Apportioning to the study area by number of commercial/institutional/government employees; (Ref. 8, 9)

Total 5 county commercial-institutional area source natural gas consumption = $(44,201 \times 10^6)(\frac{468,004}{985,800})$

= $\underline{20,984 \times 10^6 \ ft^3/year}$

Industrial(INDNGAS):

The industrial consumption of natural gas was computed by apportioning the state total industrial usage of $174,135 \times 10^6$ ft^3 (Ref. 15) by the number of manufacturing employees (Ref. 10).

Total state industrial natural gas consumption = $174,135 \times 10^6$ ft^3/year

Subtracting the state industrial point source usage of $70,288 \times 10^6$ ft^3 per year (Ref. 7, Table C-1) from this amount gives an area source natural gas consumption of $103,847 \times 10^6$ ft^3/year in the state.
Then, consumption in the 5 county region is,

Total industrial area source natural gas consumption = $(103,847 \times 10^6)(\frac{115,905}{475,121})$

= $\underline{25,333 \times 10^6 \ ft^3/year}$

The total area source consumption of natural gas in 1973 in the study area is then:

Residential	37,597 x 10^6 ft^3/year
Commercial-Institutional	20,984 x 10^6 ft^3/year
Industrial	25,333 x 10^6 ft^3/year
Total	83,914 x 10^6 ft^3/year

Emission factors input to the area 2 program with the above fuel totals were from AP-42 and are summarized in Table A-1. The total area source pollutant emissions resulting from the combustion of natural gas follow:

Source Category	Total emissions (ton/yr) - 1973				
	Partic	SO_x	CO	HC	NO_x
RESNGAS	188.0	11.3	376.0	150.4	1503.9
COMNGAS	104.9	6.3	209.8	83.9	1259.0
INDNGAS	126.7	7.6	215.3	38.0	2216.6
Totals	419.6	25.2	801.1	272.3	4979.5

Projections

The natural gas supply situation in Atlanta is unique. According to Altanta Gas Light (Ref. 14), the total quantity of gas received from their pipeline suppliers has remained constant since 1969 at approximately 2.5 x 10^9 therms/year (Ref. 52 estimated 2.3 x 10^9 therms sold in 1973). During this period, the total number of customers increased from 603,000 to 671,000. This increase was possible due to supplemental measures employed to increase reserve supplies enabling peak demand to be satisfied on winter days without increasing the total contracted supply. Though the total supply is expected to remain fixed for at least the foreseeable future, Atlanta Gas Light has been able to serve additional residential users and estimates that this trend will

continue. This is possible because of decreased gas supplies made available to commercial and industrial customers. At present and for the foreseeable future, no new customer hookups in the industrial or commercial point source categories are being accepted, and present supplies to these customers are being cutback, thus allowing the increase in residential usage to continue.

Therefore, projections of natural gas consumption to 1985 were made assuming area source commercial-institutional and industrial usage remained level at the 1973 usage rates of 20,984 x $10^6 ft^3$/year and 25,333 x $10^6 ft^3$/year respectively. Residential consumption was based on the estimated number of dwelling units using natural gas for heating purposes (Refs. 2, 3, Table B-1). To arrive at these figures, consideration was given to the gas market supply analysis provided by Atlanta Gas Light and engineering judgements of PEDCo-Environmental. Thus, the residential usage rate through 1985 was quantified to equal one third that of the 1960-1970 period, with the level gas supply situation indicating that electric power will become predominate.

The growth factors and resulting fuel usages for each study year are shown below.

Year	1973	1975	1980	1985
Number dwelling units using natural gas	399,597	410,814	440,813	473,870
Growth factor	-	1.03	1.10	1.19
RESNGAS consumption ($10^6 ft^3$/year)	37,597	38,725	41,357	44,740

Pollutant emissions from RESNGAS combustion in future years are presented in Tables 2, 3, 4, assuming that the 1973 emission factors apply to all study years.

Subarea Distribution

Emissions resulting from natural gas combustion in the study area were distributed separately by subcategory. Residential emissions from natural gas usage were distributed to all grids based upon the number of dwelling units using natural gas in each grid for each study year (Ref. 8, Table B-1). Emissions from the commercial-institutional sector were distributed in proportion to the commercial-institutional employment in each grid. Likewise, emissions resulting from natural gas combustion by the industrial category were distributed in proportion to the manufacturing employment in each grid (Ref. 8). Appendices D through P detail these apportioned emissions.

LPG

Area-wide Emissions

LPG fuel consumption in the study area was determined by following the method outlined in Reference 1 and using the state data from Reference 16.

Total state commercial and residential LPG and ethane gas consumption = $203,658 \times 10^3$ gal/year

Applying the natural gas ratio to approximate the residential/commercial usage breakdown:

$$\text{Natural gas ratio} = \frac{\text{state residential natural gas usage}}{\text{state commercial natural gas usage}}$$

$$= \frac{86,191 \times 10^6 \text{ft}^3}{47,253 \times 10^6 \text{ft}^3} = 1.82$$

Therfore, the total state residential usage equals 131,439 $\times 10^3$ gal/year and the commercial-institutional area source usage - 72,212 $\times 10^3$ gal/year (72,219 $\times 10^3$ gal less state commercial-institutional point source usage of 7 $\times 10^3$ gal - Ref. 7, Table C-1).

Residential (RESLPG):

The 5 county residential LPG usage, when apportioned from state totals by dwelling units using LPG (Refs. 2, 3, Table B-1) equals:

$$\text{Residential LPG usage} = (131,439 \times 10^3)\left(\frac{19,021}{315,019}\right)$$

$$= \underline{7,936 \times 10^3 \text{ gal/year}}$$

Commercial-Institutional (COMLPG):

The 5 county commercial-institutional LPG usage, when apportioned from state totals by number of commercial-institutional employees (Refs. 8, 9) equals:

Commercial-institutional LPG usage = $(72,212 \times 10^3)(\frac{468,004}{985,300})$

= $\underline{34,282 \times 10^3 \text{ gallons/year}}$

Industrial (INDLPG):

Industrial LPG usage was computed as follows:

Total state industrial LPG and ethane sales in 1973	=	$9,860 \times 10^3$ gal	(Ref. 16)
Less, state industrial point source usage	=	$\underline{(-)\ 1,302 \times 10^3 \text{ gal}}$	(Ref. 7, Table C-1)
Total state industrial LPG and ethane area source usage	=	$8,558 \times 10^3$ gal	

Apportioning by the manufacturing employee ratio - study area : state (Ref. 10):

Total 5 county industrial LPG and ethane area source consumption = $(8,558 \times 10^3)\ (\frac{115,905}{475,121})$

= $\underline{2,088 \times 10^3 \text{ gal/year}}$

The total area source consumption of LPG in the study area is:

Residential	$7,936 \times 10^3$ gal/year
Commercial-institutional	$34,282 \times 10^3$ gal/year
Industrial	$\underline{2,088 \times 10^3 \text{ gal/year}}$
Total	$44,306 \times 10^3$ gal/year

As before, emission factors applied to the above LPG consumption to calculate pollutant emissions are documented in Table A-1. The emissions from these 3 categories are:

Source Category	Total Emissions (tons/year) - 1973				
	Partic	SO_x	CO	HC	NO_x
RESLPG	7.3	0.1	7.7	3.0	29.8
COMLPG	31.7	0.2	33.4	12.9	197.1
INDLPG	1.8	0.0	1.6	0.3	12.2
Totals	40.8	0.3	42.7	16.2	239.1

Projections

Trends on the projected usage of LPG are quite difficult to determine. One assumption, since LPG is primarily a residential and commercial fuel, is that it will maintain its share of the market and increase proportionately with the population. However, because LPG is currently more expensive than alternative fuels for home heating, it could be assumed that there will be no increase in its usage.

It has been established in the preceeding section that natural gas will be unavailable for new commercial/industrial users in the future. In addition, estimates by the Atlanta Regional Commission are that the greatest centers of future development will be in the current rural fringe areas surrounding Atlanta, areas most probably best suited for usage of heating fuels such as LPG and fuel oil. Due to these considerations, the former assumption was used in projecting LPG usage for 1975, 1980, and 1985. Additional considerations were that the rate of change in number of dwelling units employing LPG for heating in future years was allowed to remain consistent with the 1960-1970 trend (Table B-1). Commercial and industrial usage growth factors were, as in preceeding sections, based on BEA economic growth projections for the Atlanta AQCR.

Year	1973	1975	1980	1985
No. houses using LPG	19,021	21,280	28,924	40,621
Growth factor	base	1.12	1.52	2.14
RESLPG consumption (10^3 gal/year)	7,936	8,883	12,063	16,983
Atlanta AQCR earnings for wholesale & retail trade, services and government categories (10^3 1967 $)	interpolated 3,125,592	3,420,600	4,362,300	5,557,700
Growth factor	base	1.09	1.40	1.78
COMLPG consumption (10^3 gal/yr)	34,282	37,367	47,995	61,022
Atlanta AQCR mfg. earnings (10^3 1967 $)	interpolated 1,429,884	1,577,000	2,055,000	2,490,800
Growth factor	base	1.10	1.44	1.74
INDLPG consumption (10^3 gal/yr)	2,088	2,297	3,007	3,633

Projected emissions for these 3 categories are presented in Tables 2, 3, 4.

Subarea Distribution

Computer calculated emissions from the RESLPG, COMLPG, and INDLPG subcategories were allocated to grid calls proportional to their dwelling unit LPG users (Refs. 2, 3), commercial/institutional/government employment (Ref. 8), and manufacturing employment (Ref. 8), respectively.*

*Apportioning factors can be found in Tables P-1 to P-4.

WOOD

Area-wide Emissions

Residential wood combustion was calculated according to the degree-day method described in Reference 1 and previously detailed.

The calculations are summarized by county for 1973:

County	Dwelling units using wood	x	Heating requirement factor[a]	x	Degree days per year	x	Rooms / D.U.	$(\frac{1}{5})$	=	Wood usage (tons/year)
Fulton	438		0.0017		2,999		4.8/5			2,143.7
Dekalb	61		0.0017		2,999		5.6/5			348.3
Cobb	114		0.0017		2,999		5.3/5			616.1
Clayton	55		0.0017		2,999		5.2/5			291.6
Gwinnett	336		0.0017		2,999		5.3/5			1,815.8
Totals	1,004									5,215
References	2,3		1		4		2			

[a] (tons wood/dwelling unit - degree day)

Commercial-Institutional and Industrial:

There were no data available to indicate the use of wood fuel by commercial-institutional area sources. It is expected to be quite minimal. Wood burning by industrial sources is only done as wood waste burning by the wood industry and these are included as point sources. Therefore, commercial-institutional and industrial area source emissions from wood combustion were considered to be negligible.

The emission factors applied to the residential wood fuel total to calculate emissions are included in Table A-1. Pollutant emissions in the 5 county region are:

Source category	Total emissions (ton/yr) - 1973				
	Partic.	SO_x	CO	HC	NO_x
Wood	44.3	0.0	130.4	10.4	5.2

Projections

Wood as a home heating fuel is definitely declining, especially in the urban area. This is due to home heating conversions and the renovating of older neighborhoods for various urban projects. Therefore, projections of future residential wood usage were based on the 1960-1970 rate of decrease in number of dwelling units using wood, an exponential rate as previously decribed (Table B-1).

Year	1973	1975	1980	1985
No. houses using wood	1,004	720	320	142
Growth factor	base	0.72	0.32	0.14
Wood usage (ton/yr)	5,216	3,756	1,669	730

Future pollutant emissions from wood combustion are presented in Tables 2, 3, 4.

Subarea Distribution

Allocation of emissions from wood combustion to grid cells was by the number of houses in each grid cell using wood as a heating fuel (Refs. 2, 3). Grid emissions for all study years are tabulated in Appendices D through P.

3. MOBILE SOURCES

GASOLINE HIGHWAY MOTOR VEHICLES (GASMVEH)

Area-wide Emissions

This category is broken down into 2 subcategories; gasoline powered automobiles and small trucks (LDMV) and gasoline powered large trucks (HDMV). Several methods were employed to determine the vehicle miles traveled (VMT) by these categories in the study area.

1. From Highway Statistics, the total measured VMT in Georgia in 1973 was $25,077 \times 10^6$ VMT. This figure encompasses all modes of driving by all types of vehicles on all road surfaces - interstate, primary, secondary, and local roads - both rural and urban.

Apportioning by the number of motor vehicle registrations:

Total vehicles registered in Ga. state (1973)	=	3,261,345	(Ref. 17)
Total vehicles registered in study area (1973)	=	1,021,950	(Ref. 17)
Total VMT travelled in 5 county region (1973)	=	$(\frac{1,021,950}{3,261,345})(25,077 \times 10^6)$	
	=	$\underline{7,858 \times 10^6}$ VMT/yr	

The total number of registered automobiles and small trucks in the 5 county region is 882,889. Therefore, the total VMT attributable to this light duty motor vehicle (LDMV) category equals:

Total LDMV VMT traveled in study area (1973) $= \left(\frac{882,889}{1,021,950}\right)(7,858 \times 10^6)$

$= \underline{6,789 \times 10^6 \text{ VMT}}$

2. The second method involved breaking down the fuel sales totals obtained from the State Department of Revenue (Ref. 18).

Total motor fuel sales (includes on-highway and off-highway usage) in study area (1973)	$= 1,016,330 \times 10^3$ gal/yr
Less; off-highway fuels consumed (OFHIVEH section)	$=(-) \underline{60,414 \times 10^3 \text{ gal/yr}}$
Equals; total on-highway fuels consumed	$= 955,916 \times 10^3$ gal/yr
Less; LPG sold as motor fuel	$(-) \underline{400 \times 10^3 \text{ gal/yr}}$
Equals; total on-highway gas and deisel fuel sales in study area (1973)	$= 955,516 \times 10^3$ gal/yr

From Reference 13, the total on-highway diesel fuel sales in Georgia in 1973 were: [$7,646 \times 10^3$ bbl x 42 gal/bbl = $321,132 \times 10^3$ gal/yr].

Apportioning this total to the 5 counties by the number of registered trucks and buses (Ref. 17), and assuming the percentage in the state that are diesel powered equals that in the study area:

Total trucks and buses registered in state (1973)	= 642,790
Total trucks and buses registered in study area (1973)	= 139,061

Total diesel fuel consumed in study area (1973) $= \left(\frac{139,061}{642,790}\right)(321,132 \times 10^3)$

$= 69,474 \times 10^3$ gal/yr

Therefore, the total on-highway gasoline consumption in the study area in 1973 equals:

$955,516 \times 10^3$ gal/yr
$(-)69,474 \times 10^3$ gal/yr
$= 886,042 \times 10^3$ gal/yr

If 11% of the total VMT is assumed to have been consumed by heavy duty gasoline powered trucks and LDMV's get 13.6 mi/gal and HDMV's 8.4 mi/gal, then the following describes the fuel apportionment:

$(13.6 \text{ mi/gal})(\text{gal/yr})_{LDMV} = (0.89 \text{ VMT})_{Total}$ and

$(8.4 \text{ mi/gal})(\text{gal/yr})_{HDMV} = (0.11 \text{ VMT})_{Total}$

and,

$(\text{gal/yr})_{LDMV} = [(\text{gal/yr})_{Total} - (\text{gal/yr})_{HDMV}] =$

$[(886,042 \times 10^3 \text{ gal/yr}) - (\text{gal/yr})_{HDMV}]$

then,

$$\frac{(13.6)[(886,042 \times 10^3) - (\text{gal/yr})_{HDMV}]}{0.89} = \frac{(8.4)(\text{gal/yr})_{HDMV}}{0.11}$$

The equation reduces to: $13,539.5 \times 10^6 - 15.28\ (\text{gal/yr})_{HDMV}$

$= 76.36\ (\text{gal/yr})_{HDMV}$

and,

$(\text{gal/yr})_{HDMV} = \underline{147,746 \times 10^3 \text{ gal/yr}}$

$(\text{gal/yr})_{LDMV} = 886,042 \times 10^3 - 147,746 \times 10^3 = \underline{738,296 \times 10^3 \text{gal/yr}}$

Then, the total VMT (less diesel) for 1973 in the study area is $11,282 \times 10^6$ VMT and is computed as:

LDMV VMT = 738,296 x 10^3 gal/yr x 13.6 mi/gal =

= $\underline{10,041 \times 10^6 \text{ VMT}}$

HDMV VMT = 147,746 x 10^3 gal/yr x 8.4 mi/gal =

$\underline{1,241 \times 10^6 \text{ VMT}}$

3. Since the State DOT traffic survey data is derived from traffic count measurements, it is assumed more accurate and was, therefore, used as the basis for emission computations. From the 1973 measured traffic counts and computed VMT data (Ref. 19) the following summaries were compiled for each county in the study area:

Table 3-1. TRAFFIC COUNT DATA BY COUNTY - 1973

County	Traffic type	Measured daily VMT	% total
Fulton	Rural	1,132,986	-
Dekalb	Rural	414,140	-
Cobb	Rural	921,696	-
Clayton	Rural	326,230	-
Gwinnett	Rural	1,730,904	-
Subtotal	Rural	4,525,956	17.6
All Co's.	Urban	11,110,629	43.4
All Co.'s	Freeway	9,953,091	38.9
Total	All types	25,589,676	-

The total measured annual VMT would then equal;

25,589,676 x 365 = $\underline{9,340 \times 10^6 \text{ VMT/yr}}$

Adding 20%[a] for non-measured urban streets	$9,340 \times 10^6$ VMT/yr (+)$1,868 \times 10^6$ VMT/yr
Annual total VMT (all vehicle types) in study area - 1973	= $11,208 \times 10^6$ VMT/yr

The percentage of the above total attributable to truck traffic was determined on a county basis from the traffic counts which included specific counts of truck traffic. These samples did not differentiate between diesel and gasoline powered trucks. An overall weighted average of the individual county truck traffic percentage was computed for the entire study area:

$$\bar{X}_{trucks} = \sum_{i=n-4}^{n} \frac{[\%\text{trucks measured in each county sample count}]_i \; [\text{Total VMT measured in each county sample count}]_i}{[\text{Total VMT measured in all counties sample counts}]}$$

where, n = 5(no. counties)

Thus, the overall weighted average of the study area truck traffic percentage equals 9.4%.

Therefore, the total VMT breaks down to:

Total LDMV VMT in 1973 = $(11,208 \times 10^6)(.906)$

$= 10,154 \times 10^6$ VMT/yr

Total HDMV VMT (gas & diesel) in 1973 =

$(11,208 \times 10^6)(.094) = 1,054 \times 10^6$ VMT/yr.

---

[a] The difference between measured VMT ($9,340 \times 10^6$) and VMT from all categories as computed by fuel sales reports (LDMV = $10,041 \times 10^6$; HDMV = $1,241 \times 10^6$ VMT; and, Diesel= $69,474 \times 10^3$ gal/yr x 5.1 mi/gal - 354×10^6 VMT; Grand Total - $11,636 \times 10^6$ VMT) is approximately 20%. Applying this factor allows for the portion of suburban traffic not accounted for by traffic count surveys.

Considering the inaccuracy of the average vehicle mileage factors used in Method 2, reasonably good agreement was found between the VMT computed from traffic count data and the VMT computed from the state gasoline sales ($11,208 \times 10^6$ vs. $11,636 \times 10^6$).

Further, if 80% of the total HDMV (gas & diesel) traffic is assumed to be gasoline and 20% diesel, (Ref. 1), then:

Total HDMV (gasoline) VMT in 1973 = $(1,054 \times 10^6)(.8)$

$$\underline{843 \times 10^6 \text{ VMT/yr}}$$

Total HDMV (diesel) VMT in 1973 = $(1,054 \times 10^6)(.2)$

$$= \underline{211 \times 10^6 \text{ VMT/yr}}$$

Due to source category input limitations imposed by the area 2 program (maximum capability = 25), the HDMV (gasoline) VMT was included with the LDMV VMT to yield total VMT attributable to gasoline motor vehicles in the study area in 1973 - ($10,154 \times 10^6 + 843 \times 10^6 = \underline{10,997 \times 10^6 \text{ VMT/yr}}$).

Emission factors for use with this category were derived from AP-42, Supplement 5, April 1975, incorporating the latest revisions and application of Federal Test Procedure data for EF calculations. The new methodology employed will not be discussed as the procedural changes are too numerous and the calculations too involved for inclusion herein (the reader is referred to Supplement 5, which should be readily available). In order to account for the combination of LDMV (gasoline) and HDMV (gasoline) VMT, weighted emission factors were computed. The assumptions used in computing the emission factors for each category will be listed and a brief explanation offered for each pollutant EF calculation.

LDMV

The emission factor for particulates is composed of the following components:

exhaust	0.34 gm/mi
tire wear	0.20 gm/mi
brake wear	0.02 gm/mi
Particulate emission factor for light duty motor vehicles =	0.56 gm/mi

The factors for emissions and tire wear are published figures from AP-42. The brake wear factor is unpublished but based upon 2 lb worn off per set of brake shoes each 45,000 miles. (Ref. 53).

Street dust is often times a significant factor in total particulate emissions from vehicle travel. An attempt to quantify this component is presented in Chapter 5, where dust from paved streets has been treated as a separate fugitive dust category.

The above EF for particulates and that for SO_x (0.13 gm/mi) are assumed to remain constant through 1985.

The crux of the new procedures involves calculation of composite emission factors for each calender year under consideration for CO, HC, and NO_x. The assumptions made follow:

1. Typical urban patterns of vehicle operation apply.
2. Average route speed equals 19.6 mph.
3. 20% cold engine operation.
4. Ambient temperature = 61.4° (Ref. 20).
5. Nationwide statistics for vehicle mix apply.

6. The hot start-up phase for catalyst controlled vehicles is 27% of the operating time.

7. Vehicles are catalyst controlled from 1975-1977.

Then, the composite emission factors are calculated by:

$$e_{npstw} = \sum_{i=n-12}^{n} c_{ipn}\, m_{in}\, v_{ips}\, z_{ipt}\, r_{iptw}$$, and the resultants shown below.

Year	Composite emission factors (gm/mi)				
	Partic	SO_x	CO	HC	NO_x
1973	0.56	0.13	75.9	10.2	4.4
1975	0.56	0.13	64.5	8.8	4.3
1980	0.56	0.13	30.3	5.0	2.7
1985	0.56	0.13	10.6	2.0	1.1

HDMV(gasoline)

The emission factor for particulates is composed of the following components:

exhaust	0.91 gm/mi
tire wear	0.30 gm/mi
brake wear	0.03 gm/mi

Particulate emission factor for HDMV (gasoline) = 1.24 gm/mi

The factors for emissions and tire wear are published figures from AP-42. The brake wear factor is unpublished, but based upon 3 lb worn off per set of brake shoes per 45,000 miles (Ref. 53). Again, street dust is a factor in vehicle traffic and a rough quantification of this component is shown in Chapter 5.

The emission factor for SO_x is 0.36 gm/mi. Both these factors are projected (AP-42) to remain constant through 1985.

The calculation of the composite emission factors for CO, HC, and NO_x for HDMV (gasoline) and the assumptions made follow:

1. Vehicle operation is entirely warmed up condition.
2. The vehicle mix is based on nationwide statistics.
3. Average route speed equals 18 mph.
4. The speed correction factor is based on LDMV data.
5. There exists an average of 6 tires per vehicle.

Then, the composite emission factors are calculated by:

$$e_{nps} = \sum_{i=n-12}^{n} c_{ipn} m_{in} v_{ips}.$$

They are as follows:

Year	Composite emission factors(gm/mi)				
	Partic.	SO_x	CO	HC	NO_x
1973	1.24	0.36	217.36	34.62	9.20
1975	1.24	0.36	204.90	30.20	10.20
1980	1.24	0.36	181.32	20.14	11.42
1985	1.24	0.36	138.90	12.23	12.32

The weighted emission factors incorporating those of both subcategories were computed as follows (an example computation for particulate emissions in 1973 is given for clarification):

$$\overline{EF}\ (\text{Partic}) = \frac{(10,154)(0.56) + (843)(1.24)}{(10,154 + 843)} = 0.61 \text{ gm/mi}$$

The following summarizes the weighted EF's computed:

Year	Composite emission factors (gm/mi)				
	Partic	SO_x	CO	HC	NO_x
1973	0.61	0.15	86.74	12.07	4.78
1975	0.61	0.15	75.26	10.44	4.75
1980	0.61	0.15	41.88	6.16	3.37
1985	0.61	0.15	20.44	2.78	1.97

The above EF's were input with the total VMT for LDMV and HDMV (gasoline) vehicles in the study area in 1973 (10,997 x 10^6 VMT/yr) to the Area 2 program to calculate total and apportioned emissions. Prior to this, however, the EF's were converted to lb/10^6 VMT to ensure compatability with the fuel total units (Table A-1). The resultant total emissions are:

Source Category	Total emissions (ton/yr) - 1973				
	Partic	SO_x	CO	HC	NO_x
GASMVEH	7395.8	1820.0	1,050,526.0	146,183.0	57,893.7

Projections

Emission factor development for succeeding study years has already been treated. Projections of annual VMT for gasoline motor vehicles are derived from data acquired from the Ga. State DOT (Ref. 19). Estimated VMT projection factors by county, based on factors pertaining to vehicle registrations, annual vehicle-miles, population and licensed driver distributions, and roads in service were obtained. Using these county growth factors and estimating annual VMT by county then summing to get annual VMT in the study area, an overall weighted growth factor for the entire study area evolved. The same ratio of LDMV VMT and HDMV VMT to Total VMT was assumed to prevail through 1985. The projections are:

Year	1973	1975	1980	1985
VMT Growth Factor	base	1.05	1.27	1.39
GASMVEH VMT(10^6VMT/yr)	10,997	11,547	13,966	15,286
LDMV VMT (10^6 VMT/yr)	10,154	10,662	12,896	14,114
HDMV (gasoline VMT (10^6 VMT/yr)	843	885	1,071	1,172

Projecting vehicular travel at this time, given the following uncertain trends:

1. federal motor vehicle control programs,
2. average new vehicle gas mileage,
3. federal regulations governing gasoline lead content,
4. number of people buying new cars,

is a matter to be approached with extreme caution. All aspects of the current energy market must be brought to bear. Although the above issues all generally suggest declining VMT in the future, other considerations and trends suggest that because of increases in population and probable increases in fuel economy in future motor vehicles, some upward trend in VMT could be expected over the next ten years. The major point to be impressed here is that, although the VMT projection factors probably represent the best available estimates, they should not be regarded as absolute inviolate prophecies of future activity.

Subarea Distribution

Allocation of emissions from all motor vehicle sources was based upon the distribution of total county measured VMT by functional classification (freeway, rural, urban) in each grid cell as determined from traffic count maps (Ref. 19). This total was, of course, composed of gasoline motor vehicles and diesel motor vehicles (truck) traffic. Using

the truck traffic percentage factors as previously described, the total was broken into GASMVEH VMT/grid and DIEMVEH VMT/grid (grid apportioning factors). Apportioning factors for future years were projected using the growth factors outlined above.

DIESEL HIGHWAY MOTOR VEHICLES (DIEMVEH)

Area-wide Emissions

This category includes buses and heavy duty trucks using diesel fuel. Since measured VMT data was used to determine the emissions from gasoline motor vehicles, the same VMT data was also used for this category. However, to maintain consistency, all three methods of fuel totals computations are presented for comparison.

1. From the previous section - Method 1, the total study area VMT in 1973 was calculated as $7,858 \times 10^6$ VMT. Apportioning this by the number of registered trucks and buses in the 5 county region:

$$\text{Total HDMV (gas \& diesel) VMT in study area} = (7,858 \times 10^6)\left(\frac{139,061}{1,021,950}\right)$$

$$= 1,069 \times 10^6 \text{ VMT/yr}.$$

Further, if gasoline powered trucks and buses account for 80 percent of the total and diesel powered - 20 percent, then;

$$\text{HDMV (gasoline)} = (1,069 \times 10^6)(.8) = 855 \times 10^6 \text{ VMT/yr}$$
$$\text{DIEMVEH (diesel)} = (1,069 \times 10^6)(.2) = 214 \times 10^6 \text{ VMT/yr}$$

2. From the previous section - Method 2, considering the State Department of Revenue Fuel Sales Reports, the total diesel fuel sold in the study area in 1973 was $69,474 \times 10^3$ gal/yr. Applying an average vehicle mileage factor of 5.1 mpg (Ref. 1) to this figure:

$$\text{Total DIEMVEH VMT in study area in 1973} = (69,474 \times 10^3 \text{ gal/yr})(5.1 \text{ mi/gal})$$
$$= 354 \times 10^6 \text{ VMT/yr}$$

3. The annual VMT attributable to diesel traffic as computed from county traffic count data was calculated in the previous section - Method 3, as 211 x 10^6 VMT/yr, assuming the same 80%/20% - gas/diesel truck breakdown as above. It is seen that all 3 methods of computation produce values reasonably close in magnitude, with Methods 1 and 3 being very much in agreement.

Emission factors applied to this category were determined from AP-42, Supplement 5, April 1975, in the same fashion as were those for gasoline motor vehicles. Assumptions appropriate to the calculations made will be listed here, also.

The emission factor for particulates is composed of the following components:

exhaust	1.3 gm/mi
tire wear	0.20 gm/mi
brake wear	0.03 gm/mi

Emission factor for heavy duty diesel powered motor vehicles = 1.53 gm/mi

The factors for emissions and tire wear are published figures from AP-42. The brake wear factor is unpublished, but based upon 3 lb worn off per set of brake shoes per 45,000 miles. Again, street dust is a factor in vehicle traffic and a rough quantification of this component is shown in Chapter 5.

The EF for SO_x is 2.8 gm/mi and it, along with that for particulates, remains constant through 1985 (Tables A-2, A-3, A-4).

The assumptions made for calculation of the composite emission factors for CO, HC, and NO_x are:

1. Average route speed equals 45 mph (due to large amount of interstate truck traffic in metropolitan Atlanta).

2. All engine operation is in warmed up condition.

Then, the composite emission factors are calculated by:

$e_{nps} = \sum_{i=n-12}^{n} c_{ipn}\, m_{in}\, v_{ips}$, and the resultants shown below:

Year	Composite emission factors (gm/mi)				
	Particulate	SO_x	CO	HC	NO_x
1973	1.53	2.8	8.6	2.3	25.1
1975	1.53	2.8	8.6	2.3	25.1
1980	1.53	2.8	8.6	2.3	24.2
1985	1.53	2.8	8.6	2.3	25.2

After converting the emission factors to a $lb/10^6$ VMT basis, they were input, with the DIEMVEH VMT total, to the Area 2 Program for total and apportioned emissions calculations. The EF's in appropriate input form are presented in Table A-1. The resultant emissions for 1973 are:

Source category	Total emissions (tons/year) - 1973				
	Particulate	SO_x	CO	HC	NO_x
DIEMVEH	355.9	650.6	1998.4	534.5	5832.7

Projections

Projections of future VMT for diesel motor vehicles were developed identically to those for gasoline motor vehicles. The growth factors provided by the GA. State DOT pertaining to the county total VMT projections were assumed to apply to travel by this category also.

Again, the same vehicle mix and ratio of DIEMVEH VMT/Total VMT were assumed to apply through 1985. These projections should be viewed with the same astute awareness as those for gasoline motor vehicles.

Year	1973	1975	1980	1985
VMT Growth Factor	base	1.05	1.27	1.39
Total VMT (10^6 VMT/yr)	11,208	11,769	14,235	15,579
DIEMVEH VMT (10^6 VMT/yr)	211	222	267	293

Subarea Distribution

Allocation of emissions from this category was performed exactly as that for gasoline motor vehicles. They are tabulated in Appendices D through P.

AIRCRAFT (AIRCRAFT)

Area-wide Emissions

The effects of aircraft upon air quality are attributable to nine airports of significant size in the study area. The number of operations by aircraft category were obtained by several means, and formed the basis for emissions calculations.

It was desired to obtain FAA Master Records for each airport in the study area. However, personnel at the FAA Regional Office in Atlanta indicated that, due to workload, these would have to be extracted from their files personally by the requester. Therefore, other sources of more readily avaliable published data were consulted to obtain the required information.

Data presented in Tables 3-2A and 3-2B (Ref. 21,22,23) were used in computing the emissions by airports since this information gave the best breakdown by aircraft category for each airport. Data expressed in Table 3-4 was used for introduction in the Area "2" program because it was developed expressly for projected estimates of future airport activity (Ref. 25).

Aircraft operations at airports with FAA operated air traffic control facilties (Wm. B. Hartsfield, Dekalb Peachtree, and Fulton County Airports) were obtained from Reference 21 - FAA Air Traffic Activity Report. Data pertaining to military operations at Dobbins Air Force Base were obtained from Reference 22 - Military Air Traffic Activity Report, after repeated unsuccessful attempts to obtain more specific data from the Air Operations officer at Dobbins. Operations activity reflected for all the general aviation (G/A) airports were based upon the number of aircraft in each category based at the respective airport (Ref. 23). It was assumed that the

Table 3-2A. LTO CYCLES BY AIRPORT.

Aircraft category	LTO Cycles by Airport									
	Total LTO cycles	Wm. B. Hartsfield (Atl. Int'l.)	Dekalb Peachtree	Fulton county	McCollum airfield	Stone Mountain	Gwinnett county	South expressway	South Fulton skyport	Dobbins AFB
Air Carrier[a]	220,810	220,807	0	3	-	-	-	-	-	-
Air Taxi-Turboprop	8,067	8,473	144	50	-	-	-	-	-	-
General Aviation[c]										
S/E Piston	321,538	23,494	73,984	85,313	28,470	35,040	24,455	35,040	10,220	5,522
M/E Piston	59,932	5,873	18,496	21,328	8,395	1,460	2,920	1,460	-	-
Military[b]										
Jet	19,642	-	-	-	-	-	-	-	-	19,642
Transport	25,769	696	444	4,987	-	-	-	-	-	19,642
Piston	4,365	-	-	-	-	-	-	-	-	4,365
TOTALS	660,723	259,343	93,068	111,681	36,865	36,500	27,375	36,500	10,220	49,171

[a] LTO cycles = No. reported operations/2 (Ref. 21).

[b] LTO cycles = No. reported operations/2 (Ref. 22).

[c] LTO cycles = No. reported operations/2 (Ref. 23).

Table 3-2B. ESTIMATED ANNUAL EMISSIONS BY AIRCRAFT CATEGORY.

Aircraft category	Total LTO cycles	Number of engines	Emission factors (lb/eng-LTO)[b]					Emissions (tons/year)				
			Particulate	SO_2	CO	HC	NO_x	Particulate	SO_2	CO	HC	NO_x
Air Carrier	220,810	3[a]	1.21	1.56	47.4	41.2	7.9	401	517	15,700	13,64	2,617
Air Taxi-Turboprop	8,667	2	1.1	0.4	6.6	2.9	2.5	10	3	57	25	22
General Aviation												
S/E Piston	321,538	1	0.02	0.014	12.2	0.4	0.047	3	2	1,961	64	8
M/E Piston	59,932	2	0.02	0.014	12.2	0.4	0.047	1	1	731	24	3
Military												
Jet	19,642	2	0.31	0.76	15.1	9.93	3.29	6	15	297	195	65
Transport	25,769	4	1.1	0.41	5.7	2.7	2.2	57	21	294	139	113
Piston	4,365	2	0.28	0.14	152	20.4	0.2	1	neg.	663	89	1
TOTALS	660,723							479	559	19,703	14,182	2,829

[a] Average number of engines for all airplanes in this category (medium range jets) using these fields.

[b] Emission factors for each class of aircraft are based upon LTO operations by mode (e.g. taxi-idle, takeoff - Ref. 11).

Table 3-3. AIRCRAFT EMISSIONS BY AIRPORT - 1973

Airport	Aircraft category	Emissions (tons/year) - 1973				
		Particulate	SO_x	CO	HC	NO_x
Wm. B. Hartsfield (Atlanta International) (Grids: 82-30%, 84-40%, 81-30%)	Air Carrier	401.0	517.0	15,700.0	13,646.0	2,617.0
	Air Taxi - Turboprop	9.8	2.9	55.7	24.4	21.5
	G/A. - S/E Piston	0.2	0.1	143.3	4.7	0.6
	G/A. - M/E Piston	0.1	0.1	71.6	2.3	0.3
	MIL. - Transport	1.5	0.6	7.9	3.8	3.1
	Total	412.6	520.7	15,978.5	13,681.2	2,642.5
Dekalb Peachtree (Grid 21)	Air Taxi - Turboprop	0.2	0.1	1.0	0.4	0.4
	G/A. - S/E Piston	0.7	0.5	451.0	14.7	1.8
	G/A. - M/E Piston	0.3	0.3	225.6	7.4	0.9
	MIL. - Transport	1.0	0.4	5.0	2.4	1.9
	Total	2.2	1.3	682.6	24.9	5.0
Fulton County (Grid 25)	Air Carrier	neg.	neg.	neg.	neg.	neg.
	Air Taxi - Turboprop	0.1	neg.	0.3	0.2	0.1
	G/A. - S/E Piston	0.8	0.5	520.3	17.0	2.1
	G/A. - M/E Piston	0.4	0.4	260.1	8.5	1.1
	MIL. - Transport	11.0	4.1	56.9	27.0	21.9
	Total	12.3	5.0	837.6	52.7	25.2
McCollum Airfield (Grid 18)	G/A. - S/E Piston	0.3	0.2	173.6	5.6	0.7
	G/A. - M/E Piston	0.1	0.1	102.4	3.4	0.4
	Total	0.4	0.3	276.0	9.0	1.1
Stone Mountain (Grid 32)	G/A. - S/E Piston	0.3	0.2	213.7	7.0	0.9
	G/A. - M/E Piston	neg.	neg.	17.8	0.6	0.1
	Total	0.3	0.2	231.5	7.6	1.0
Gwinnett County (Grid 5)	G/A. - S/E Piston	0.2	0.2	149.1	4.9	0.6
	G/A. - M/E Piston	neg.	neg.	35.6	1.2	0.1
	Total	0.2	0.2	184.7	6.1	0.7
South Expressway (Grid 91)	G/A. - S/E Piston	0.3	0.2	213.7	7.0	0.8
	G/A. - M/E Piston	neg.	neg.	17.8	0.6	neg.
	Total	0.3	0.2	231.5	7.6	0.8
South Fulton Skyport (Grid 88)	G/A.-S/E Piston	0.1	0.1	62.3	1.9	0.2
	Total	0.1	0.1	62.3	1.9	0.2
Dobbins AFB (Grids: 10-50%, 11-40%, 19-10%)	G/A. - S/E Piston	neg.	neg.	33.7	1.1	0.1
	MIL. - Jet	6.0	15.0	297.0	195.0	65.0
	MIL. - Transport	43.4	16.0	224.1	105.9	86.1
	MIL. - Piston	1.0	neg.	663.0	89.0	1.0
	Total	50.4	31.0	1,217.8	391.0	152.2
Total (all airports)		479.0	559.0	19,703.0	14,182.0	2,829.0

annual activity would closely equal the product of the number of based aircraft and 365. More accurate data for most of these small facilities is unavailable and detailed records are often not kept, even by the Fixed Base Operators themselves.

Emission factors were obtained directly from AP-42. The number of engines for each category is directly obvious except for the air carrier category. In this case, Reference 24 was surveyed to determine the number of daily arrivals and departures, by aircraft type, from Atlanta International Airport. Medium range jet activity predominates and the estimate, 3 engines/plane, a reasonable figure. Several other assumptions were necessary in order to further classify the operational activity, select appropriate emission factors, and calculate emissions. They are hereby listed:

1. Dobbins Air Force Base
   a. Assume military operations are 45 percent jet, 45 percent 4 engine turboprop, and 10 percent piston driven aircraft.
   b. Assume civilian operations occurring are general aviation single engine piston driven aircraft, most probably operated by military flying clubs on base.

2. Civilan Fields
   a. Assume all military operations at civilian fields are by 4 engine transport type aircraft.
   b. Assume G/A traffic at all airports equals 80 percent single engine and 20 percent multi-engine.
   c. Assume air taxi operations are 2 engine air carrier turboprop type aircraft.

Projections

Air carrier traffic, in general, has been cut back in efforts to conserve fuel and promote more efficient utilization of aircraft. However, analysis of projected air traffic activity at the Atlanta regional level portends significant facilities expansion programs at least through FY-77, with anticipated increases in operational activity of 36-77 percent through 1985. This tremendous growth potential for air travel in Metropolitan Atlanta, particularly for Atlanta International Airport - already one of the 10 busiest airports in the country - is portrayed in detail in Reference 25. Therefore, it was determined that projections presented therein would also serve as reasonably accurate predictors of emissions from this category for Dekalb Peachtree, and Fulton County Airports. The city of Atlanta has recently purchased land for a new airport to be located in Paulding County. However, it is not expected to be operational before 1985 and the emissions therefrom would not constitute an additional source in the present study area.

Indications are that general aviation air traffic is also increasing, despite uncertainties surrounding the current energy market. Since no hard statistics were available for the smaller, primarily general aviation fields, projections were made based on the average estimated annual increase in general aviation activity occurring at the larger airports (above) - 6.2 percent/year.

Projections of military flying activity are extremely difficult to prepare due to cutbacks in defense budget appropriations and military-wide austerity and streamlining programs. Currently, Pentagon policy is to reduce active force strength and promote greater expansion, utilization and mobilization of the reserve programs, especially the Selected Air Reserve. Thus, it is assumed that an increase in one will be offset

Table 3-4. GROWTH DATA AND PROJECTED EMISSIONS BY AIRPORT

Airport	Year	Total operations	Growth factor	Emissions (tons/year)				
				Particulate	SO_x	CO	HC	NO_x
Wm. B. Hartsfield[a] (Atlanta International) (Grids: 82-30B, 84-40B, 81-30B)	1973	500,000	-	412.6	520.7	15,978.5	13,681.2	2,642.5
	1975	517,000	1.03	425.0	536.3	16,457.9	14,091.6	2,721.8
	1980	648,000	1.30	536.4	676.9	20,772.1	17,785.6	3,435.3
	1985	757,000	1.51	623.0	786.3	24,127.5	20,658.6	3,990.2
Dekalb Peachtree[a] (Grid 21)	1973	171,000	-	2.2	1.3	632.6	24.9	5.0
	1975	182,000	1.06	2.3	1.4	723.6	26.4	5.3
	1980	242,000	1.42	3.1	1.8	969.3	35.4	7.1
	1985	302,000	1.77	3.9	2.3	1,208.2	44.1	8.9
Fulton County[a] (Grid 25)	1973	233,000	-	12.3	5.0	837.6	52.7	25.2
	1975	242,000	1.04	12.8	5.2	871.1	54.6	26.2
	1980	279,000	1.20	14.8	6.0	1,005.1	63.2	30.2
	1985	317,000	1.36	16.7	6.8	1,139.1	71.7	34.3
McCollum Airfield[b] (Grid 18)	1973	73,730	-	0.4	0.3	276.0	9.0	1.1
	1975	82,578	1.12	0.4	0.3	309.1	10.1	1.2
	1980	105,434	1.43	0.6	0.4	394.7	12.9	1.6
	1985	128,290	1.74	0.7	0.5	480.2	15.7	1.9
Stone Mountain[b] (Grid 32)	1973	73,000	-	0.3	0.2	231.5	7.6	1.0
	1975	81,760	1.12	0.3	0.2	259.3	8.5	1.1
	1980	104,390	1.43	0.4	0.3	331.0	10.9	1.4
	1985	127,020	1.74	0.5	0.3	402.8	13.2	1.7
Gwinnett County[b] (Grid 5)	1973	54,750	-	0.2	0.2	184.7	6.1	0.7
	1975	61,320	1.12	0.2	0.2	206.9	6.8	0.8
	1980	78,293	1.43	0.3	0.3	264.1	8.7	1.0
	1985	95,265	1.74	0.3	0.3	321.4	10.6	1.2
South Expressway[b] (Grid 91)	1973	73,000	-	0.3	0.2	231.5	7.6	0.8
	1975	81,760	1.12	0.3	0.2	259.3	8.5	0.9
	1980	104,390	1.43	0.4	0.3	331.0	10.9	1.1
	1985	127,020	1.74	0.5	0.3	402.8	13.2	1.4
South Fulton Skyport[b] (Grid 88)	1973	20,440	-	0.1	0.1	62.3	1.9	0.2
	1975	22,893	1.12	0.1	0.1	69.8	2.1	0.2
	1980	29,229	1.43	0.1	0.1	89.1	2.7	0.3
	1985	35,566	1.74	0.2	0.2	108.4	3.3	0.3
Dobbins AFB[c] (Grids: 10-50B, 11-40B, 19-10B)	1973	98,342	-	50.4	31.0	1,217.8	391.0	152.2
	1975	98,342	1.0	50.4	31.0	1,217.8	391.0	152.2
	1980	98,342	1.0	50.4	31.0	1,217.8	391.0	152.2
	1985	98,342	1.0	50.4	31.0	1,217.8	391.0	152.2
Totals	1973	1,297,262	-	479	559	19,763	14,182	2,829
	1975	1,369,653	1.06	492	575	20,375	14,600	2,910
	1980	1,689,078	1.30	607	717	25,374	18,321	3,630
	1985	1,987,503	1.53	696	828	29,408	21,221	4,192

[a] Operations from actual published activity projection data (Ref. 25).

[b] Growth factors equal the average %/yr increase in general aviation operations at Dekalb Peachtree and Fulton County airports (6.2%/yr).

c No projected increase in activity available - engineering judgement of PEDCo-Environmental.

by a decrease in the other and, therefore, emissions from aircraft are shown to remain level through 1985. Projected emissions by airport are presented in Table 1-4.

Subarea Distribution

Aircraft are considered area sources and the emissions from them are applied to the grids at the airport locations. For purposes of computation then, aircraft emissions were input to the Area 2 Program as "hand calculated emissions" and added to the apportioned emissions of the appropriate grid cells (Appendices D through F).

RAIL LOCOMOTIVE (RAILLOC)

Area-wide Emissions

Emissions as a result of railroad activity in the five county area were computed from the reported state railroad fuel usage (Ref. 13).

Total state fuel oil (mainly distillate) usage by railroad (1973)[a] = $2,845 \times 10^3$ bbl x 42 gal/bbl

$= 119,490 \times 10^3$ gal/yr

This quantity was then apportioned to the study area by railroad track mileage:

Total railroad track mileage in study area = 271 (Ref. 26)

Total state railroad track mileage = 5,417 (Ref. 27)

Total county fuel oil usage by railroad = $(119,490 \times 10^3)(\frac{271}{5417})$

$= 5,978 \times 10^3$ gal/yr

Emission factors, based on average locomotive statistics (Table A-1), were applied to the above fuel consumption to yield total pollutant emissions for this category of:

Source category	Total emissions (tons/year) - 1973				
	Particulate	SO_x	CO	HC	NO_x
RAILLOC	74.7	170.4	388.6	281.0	1105.9

Projections

The railroad industry in general has shown a decrease in activity in the past several decades. However, at least one factor can be cited to indicate a possible growth trend in

[a] Assumes all fuel sold in the state, but not used in the state equals that not sold in the state, but used in the state.

railroad activity for succeeding years, provided the recession comes to an end. Although no quantitative measure of this factor was obtained, it remains that the hauling of coal by the railroads is likely to increase as dwindling supplies of cleaner fuels place more importance on coal as an energy source. However, attempts to quantify this increase would be difficult. Therefore, all other subjective indications pointed to a leveling off of emissions from 1975-1985. Fuel usage by railroads in 1975, 1980 and 1985 will be held at $5{,}978 \times 10^3$ gal/yr and projected emissions are as presented in Tables 2, 3 and 4.

Subarea Distribution

The miles of railroad track in each grid were measured from USGS topographic maps of the study area. The total measured mileage was 671. Since the county contains 271 miles of mainline track (Ref. 26), the difference was attributed to grids where major track or yard facilities were noted. Thus, allocating proportionately to the measured track mileage rather than the mainline mileage will more heavily weight the grids containing greater railyard activity. Switch engine activity in the yards was assumed to be included in the emissions allotted to the grids with yard activity. The total emissions from this category were then distributed to each grid on the basis of track mileage contained in the grid.

VESSELS (VESSELS)

Area-wide Emissions

Estimation of pollutant emissions attributable to vessel traffic in the study area was limited to determining the pleasure boat contribution, since Atlanta is not served by a port and the Chattahoochee River carries little commercial traffic. On the other hand, there are a number of small lakes in the area, Lakes Lanier and Alatoona being heavily utilized for pleasure boating purposes.

Several local agencies were contacted in an attempt to determine the number of registered pleasure boats in the study area. However, this data appeared to be undocumented. Therefore, the 1973 state boat registration total of 200,000 boats (Ref. 28) was used, in accordance with procedures set forth in Reference 1, for calculating emissions.

Fuel consumption by vessel activity:

No. registered boats in state = 200,000 (Ref. 28)
Inland water surface area (state) = 803 mi^2 (Ref. 29)
Inland water surface area (study area)[a] = 21 mi^2 (Ref. 30)
Fuel usage factor = 160 gal/boat-year (Ref. 1)

Fuel consumption (state) 1973 = (200,000 boats)(160 gal/boat-year)
= 32,000 x 10^3 gal/year.

Fuel consumption (study area) 1973 = $(32{,}000 \times 10^3)(\frac{21}{803})$
= $\underline{837 \times 10^3 \text{ gal/year}}$

Emission factors for input to the Area 2 Program with the above fuel total were taken directly from the outboard

[a] Includes lakes and streams greater than 1 acre in size.

powered vessels section of AP-42 and are listed in Table A-1.

Emissions for 1973 then, are:

Source category	Total emissions (tons/year) 1973				
	Partic.	SO_x	CO	HC	NO_x
VESSELS	0	2.7	1381.0	460.3	2.8

Projections

In today's conservation intensive fuel market, predicting future fuel use trends is difficult, to say the least. Ideally, predictions for this category would best be made based on estimations of future pleasure boat registrations or fuel consumption. However, these data were unavailable. Therefore, projections have been derived from population growth factors (Ref. 31), reducing the factor by 50 percent due to all subjective indications pointing to expected decreases in fuel usage by secondary consumption sources.

Therefore, future estimations of fuel usage are:

Year	1973	1975	1980	1985
Total population	1,522,800	1,612,725	1,887,782	2,209,845
Growth factor	base	1.06	1.24	1.45
Adjusted growth factor	base	1.03	1.12	1.23
VESSEL fuel usage (10^3 gal/year)	837	862	937	1,030

Corresponding emissions for the study years are presented in Tables 2, 3, 4.

Subarea Distribution

Pollutant emissions were allocated to grid cells in proportion to the inland water acreage area present therein, determined from USGS maps (Appendices D through P).

OFF-HIGHWAY VEHICLES (OFHIVEH)

Area-wide Emissions

This category includes off-highway vehicles using diesel and gasoline fuels. Typical gasoline fuel users are farm tractors, lawnmowers, compressors, pumps, and small electric generators. Typical diesel fuel users are farm tractors, construction equipment, emergency generator power units, and compressor engines. Of the farm tractors, approximately 60 percent are assumed to be gasoline powered (Ref. 1).

Two methods were employed to check fuel consumption by this category. For the first, state fuel totals were apportioned to the counties by population:

1. Gasoline:

GA State Off-highway Gasoline usage (1973) $= 51,552 \times 10^3$ gal/yr (Ref. 17)

Study Area Off-Highway Gasoline usage (1973)

$$= (51,552)\left(\frac{1,522,000}{4,786,000}\right)$$

$$= \underline{16,394 \times 10^3 \text{ gal/yr}}$$

2. Diesel Fuel:

GA. State Off-Highway Diesel Fuel usage (1973)

$$= 1,284 \times 10^3 \text{ bbl/yr (Ref. 13)}$$

$$\underline{\times \quad 42 \text{ gal/bbl}}$$

$$= 53,928 \times 10^3 \text{ gal/yr}$$

Study area Off-Highway Diesel Fuel Usage (1973)

$$= (53,928)\left(\frac{1,522,000}{4,786,000}\right)$$

$$= \underline{17,150 \times 10^3 \text{ gal/yr}}$$

The second method entailed applying the fuel use factors published in Reference 1:

1. Gasoline:

Tractor gasoline consumption rate = 1,000 gal/tractor-yr
Total tractors in study area = 1,668 (Ref. 51)[a]
Gasoline tractors study area = 1,668 (.6)[b]
= 1,000

Total tractor gasoline usage = (1,000)(1,000)
= $\underline{1{,}000 \times 10^3 \text{ gal/yr}}$

"Other" gasoline consumption factor = 13 gal/capita/yr (Ref. 1)
"All other" gasoline usage = 13(1,522,800)
= $\underline{19{,}796 \times 10^3 \text{ gal/yr}}$

Therefore, total off-highway gasoline consumption equals $\underline{20{,}796 \times 10^3 \text{ gal/yr}}$, compared to $16{,}394 \times 10^3$ gal/yr, calculated by Method 1.

2. Diesel Fuel:

Tractor diesel fuel consumption rate = 1,000 gal/tractor-yr
Diesel tractors in study area = 1,000 (.35)[b]
= 584

Total diesel tractor diesel fuel usage = (584)(1,000)
= $\underline{584 \times 10^3 \text{ gal/yr}}$

---

[a] 1969 data; assume same number for 1973 due to the normal expected increase being offset by counteracting trends such as decreasing farmland availability due to urban encroachment.

[b] Of tractor total: 60% are gasoline powered, 35% are diesel powered, and 5% are LPG powered (Ref. 1).

Construction equipment
fuel usage rate = 5,000 gal/non-bldg. construction employee-yr

Total non-bldg. construction employees in study area = 5553 (Ref. 32)

Total construction equipment
diesel fuel usage = (5,000)(5,553)
= $27,765 \times 10^3$ gal/yr

"Other" diesel fuel usage factor = 7.4 gal/capita-yr (Ref. 1)

Total "All Other" diesel fuel
usage = (7.4)(1,522,800)
= $11,269 \times 10^3$ gal/yr

Therefore, total off-highway diesel fuel consumption in the study area equals $39,618 \times 10^3$ gal/yr, compared to $17,150 \times 10^3$ gal/yr, computed by Method 1. Due to inaccuracies inherent with geographical apportioning techniques and the tendency of BOM state totals to be underestimated, the fuel use quantities calculated by Method 2 were used for emissions calculations. Since this whole category was to be considered as an entity, the total fuel usage for input to the Area 2 Program was: $20,796 \times 10^3$ gal/yr + $39,618 \times 10^3$ gal/yr = $60,414 \times 10^3$ gal/yr.

There are no directly applicable emission factors for off-highway sources. A composite emission factor, based upon a weighted average of light duty motor vehicle emission factors and diesel motor vehicle emission factors, was applied to the composite fuel total. Since smaller engines are probably not as efficient as larger engines, this was felt to be a reasonable approach. The derivation follows:

Table 1-5. EMISSIONS FACTOR DERIVATION-OFF-HIGHWAY VEHICLES

Emission factor	Partic.		SO_x		CO		HC		NO_x	
	Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel
gm/mi (1)	0.56	1.53	0.13	2.8	75.9	8.6	10.2	2.3	4.4	25.1
mi/gal (2)	12.2	5.1	12.2	5.1	12.2	5.1	12.2	5.1	12.2	5.1
gm/gal (1x2)	6.83	7.8	1.59	14.3	926	43.9	124.4	11.7	53.7	128
wt'd avg. (gas & diesel)	$\frac{(20,796)(6.83)+(39,618)(7.8)}{60,414}$		$\frac{(20,796)(1.59)+(39,618)(14.3)}{60,414}$		$\frac{(20,796)(926)+(39,618)(43.9)}{60,414}$		$\frac{(20,796)(124.4)+(39,618)(11.7)}{60,414}$		$\frac{(20,796)(53.7)+(39,618)(128)}{60,414}$	
gm/gal	7.47		9.9		347.4		50.5		102.4	
lb/10^3 gal [a]	16.4		21.8		765.2		111.3		220	

[a]Input to Area 2 Program/presented in Table A-1.

Total estimated emissions for the off-highway vehicles category, including both gasoline and diesel fuel users, are as shown:

Source category	Total emissions (tons/year) - 1973				
	Partic.	SO_x	CO	HC	NO_x
OFHIVEH	495.4	658.5	23,114.4	3360.5	6645.5

Projections

Although unobtainable, State projections of fuel consumption for this category would depict the most accurate usage. Therefore, they were based on population growth projections (Ref. 31), employing just 50 percent of the growth factor because of expected declining fuel availability for secondary consumption categories such as this.

Year	1973	1975	1980	1985
Total population	1,522,800	1,612,725	1,887,782	2,209,845
Growth factor	base	1.06	1.24	1.45
Adjusted growth factor	base	1.03	1.12	1.23
OFHIVEH Fuel Usage (10^3 gal/yr)	60,414	62,226	67,664	74,309

It is to be noted that, since off-highway vehicles are essentially uncontrolled, the 1973 emission factors have been assumed to apply through 1985 (Tables A-2, A-3, A-4).

Subarea Distribution

The calculation of emissions from this category is based almost entirely on population. The allocation of emissions to each grid were, therefore, distributed proportionately to the grid population (Ref. 49) of each study year. These distributions are shown in Appendices D through P.

4. COMBUSTION OF SOLID WASTES (CONTROLLED AND UNCONTROLLED)

OPEN BURNING (REFUSE)

Area-wide Emissions

There are three classifications that should be considered in this category: a) leaf burning outside the urban services area, b) residential on-site burning and c) unintentional structural fires.

a) The residential area outside the urban services area was assumed to include primarily older rural homes, where leaf raking is often not done, and newer suburban development homes, where trees are rarely large enough to produce enough leaves to require raking and burning. This, therefore, was considered a negligible category.

b) In Georgia, open burning in counties with a population greater than 25,000 is prohibited. All the counties in the study area come under this restriction. However, it is probable that a sizable amount of residential refuse still is disposed of by open burning. Therefore, the policy set forth by GA. DNR at allowing 0.5 lb refuse burned/cap.-day was adopted here as being a reasonable estimate. Commercial and industrial open refuse burning were considered negligible.

Total res. refuse combustion (tons/year) = (0.5 lb/cap-day)(365)(1,522,800)(ton/2000 lb)

= 138,956 tons refuse burned/year.

In computing emission factors for this subcategory, it was assumed that the waste was a mixture of municipal refuse,

wood refuse, and landscape refuse and pruning waste. Therefore, the computed emission factors were the arithmetical average of the factors given for these classifications in AP-42. These EF's were further averaged with those pertaining to unintentional structural fires to yield a weighted average set of emission factors for the entire category (Table A-1).

c) Unintentional structural fires in 1973 numbered 6,484 in the 5 county area. The data are documented below by count .

Table 4-1. STRUCTURAL FIRES BY COUNTY - 1973

County	No. structural fires	
Fulton	277	(Ref. 33)
Dekalb	2,025	(Ref. 34)
Cobb	691	(Ref. 35)
Clayton	950	(Ref. 36)
Gwinnett	296	(Ref. 37)
Atlanta	2,245	(Ref. 38)
Total	6,484	

Structural fires listed by county include those for unincorporated areas only - exclusive of fires occurring in towns or cities. Due to the large number of small towns and cities contained in the study area, it was impossible to contact all local fire departments individually. Therefore, only fires occurring within the city limits of Atlanta were included in the data summary.

A general method suggested in Reference 1 to estimate the average number of fires occurring among a populace uses a factor of 4 fires/1000 residents:

Total structural fires = (4 fires/10^3 capita)(1,522,800) = 6,088, which agrees quite closely with the actual figure of 6,484.

Assuming no catastrophic fires, an average factor of 5 tons of wood burned per fire, an engineering judgement of PEDCo-Environmental, was used to estimate emissions.
Therefore, total wood burned in study area (tons/year) in 1973 equals (6484 fires/yr)(5 tons wood burned/fire)
= 32,420 tons wood burned/year

Emission factors for this subcategory were derived from the wood refuse table in AP-42 and an overall weighted EF for both subcategories of this source was computed (Table A-1), since it was desired that they be combined as an entity for calculation purposes. These EF's then, were input with the total fuel consumed - 171,376 tons/year - to the Area 2 program to calculate pollutant emissions:

Source category	Total emissions (tons/year) - 1973				
	Particulate	SO_x	CO	HC	NO_x
OPENBUR	1431.0	17.1	5329.8	1319.6	257.1

Projections

Leaf burning is expected to remain a negligible factor in open burning outside the urban services area. There are a number of theories that could be postulated to project residential on-site burning emissions. One seemingly obvious one is that as population increases, open burning increases by the same percentage. The assumption made in this study was that as population increases, emissions from this category will decrease by the same percentage. The reasoning follows: 1) air pollution control regulations will become more stringent in the future and enforcement policies stricter, 2) more

refined methods of solid waste disposal and recycling will be utilized making solid waste less economically feasible to dispose of in a wasteful fashion, 3) urban development and the trend toward multi-family dwellings indicates that less space per capita will be available where burning could occur.

Subjective indications from personnel associated with the various fire bureaus contacted are that unintentional structural fires indicate a decreasing trend, probably due to upgrading of the downtown sections of the city and tearing down of many older fire-prone residences. For similar reasons as above, the number of fires burned for each projection year was adjusted downward by the same percentage as the total population increased.

Year	1973	1975	1980	1985
Total population	1,522,800	1,612,725	1,887,782	2,209,845
Growth factor	base	1.06	1.24	1.45
Adjusted growth factor	base	0.94	0.76	0.55
OPENBUR fuel usage (tons/yr)	171,376	161,093	130,246	94,257

OPENBUR emissions for future years are presented in Tables 2, 3 and 4, assuming that the same emission factors prevail as in 1973 (Tables A-2, A-3 and A-4).

Subarea Distribution

Computed emissions were allocated to grid cells proportional to each grid's study year population (Ref. 31), and are tabulated in Appendices D through P.

INCINERATION (INCINERA)

Area-wide Emissions

A listing of all known non-point source incinerators in the study area, the type and quantity of refuse burned in each, and the number of days operated per year was recently compiled by Georgia DNR. This listing is shown in Table 4-2. While the data are representative of 1975, not the base year 1973, they probably provide the best available estimate of the 1973 refuse burning rates for the incinerators still in operation. However, the total refuse burned could be low because several incinerators may have been shut down during 1973 and 1974. Nevertheless, in the absence of more detailed information, it was assumed that the total refuse burned in 1973 equalled that presented for 1975.

Table 4-3 shows the classification system for incinerated wastes, lending definition to the waste type indicators listed by incinerator in Table 4-2. Emission factors then, were selected based on knowledge of these data. Commercial incinerators were assumed to be multiple chamber unless indicated as pathological or otherwise. Sewage sludge incinerators were assumed to be controlled.

Then, to arrive at emissions:

Incinerator emissions (tons/year) = (lb. refuse burned/day)(days operated/year)(ton/2000 lb)(lb. pollutant emitted/ton refuse burned)(ton/2000 lb)

The total refuse combusted in this category was 21,758 tons/year and the total emissions are:

Table 4-2. LIST OF NON-POINT SOURCE INCINERATORS BY COUNTY - 1975

Incinerator/Location	Grid	Refuse burned (lb/day)	Days operated per year	Refuse burned (tons/year)	Type waste	Emission Factors (lb/ton)					Emissions (tons/year)				
						Particulate	SO_x	CO	HC	NO_x	Particulate	SO_x	CO	HC	NO_x
Clayton Co.															
Clayton General Hospital Riverdale, GA.	91	400	365	73	1	7	2.5	10	3	3	0.3	0.1	0.4	0.1	0.1
GEX Store 4150 S. Expressway, Atlanta	84	2,400	310	372	0	7	2.5	10	3	3	1.3	0.5	1.9	0.6	0.6
Farmer's Market 19 Hunter St. S.W., Atlanta	85	250	100	12.5	1 & 2	7	2.5	10	3	3	neg.	neg.	neg.	neg.	neg.
Winn-Dixie Stores, Inc. 2800 Jonesboro Rd.; Forest Park	85	1,200	300	180	0	7	2.5	10	3	3	0.6	0.2	0.9	0.3	0.3
Cobb Co.															
Cobb General Hospital 3950 Austell Rd., Austell, GA.	25	300	260	39	4-I	8	neg.	neg.	neg.	3	0.1	neg.	neg.	neg.	neg.
Rabies Control Center Prison Farm Rd.; Marietta, GA.	10	4,000	250	500	4	8	neg.	neg.	neg.	3	2	neg.	neg.	neg.	0.8
Citizen's Jewelry Co. 2950 South Highway 41; Atlanta	11	330	300	49.5	1	7	2.5	10	3	3	0.2	neg	0.2	neg.	neg.
Kennestone Hospital 737 Church St.; Marietta, GA.	1	4,650	312	725.4	1 & 4	7	2.5	10	3	3	2.5	0.9	3.6	1.1	1.1
McDonald's Corporation Bells Ferry Rd. & Highway 41; Marietta, GA.	1	400	365	73	1 & 2	7	2.5	10	3	3	0.3	0.1	0.4	0.1	0.1

Table 4-2 (Continued). LIST OF NON-POINT SOURCE INCINERATORS BY COUNTY - 197

Incinerator/Location	Grid	Refuse burned (lb/day)	Days operated per year	Refuse burned (tons/year)	Type waste	Emission Factors (lb/ton)					Emissions (tons/year)				
						Particulate	SO_x	CO	HC	NO_x	Particulate	SO_x	CO	HC	NO_x
Urban Medical Hospital 2540 Windy Hill Road, Marietta, GA.	11	50	260	6.5	4	8	neg.	neg.	neg.	3	neg.	neg.	neg.	neg.	neg.
Dekalb Co.															
Dekalb General Hospital 2701 N. Decatur Road, Decatur, GA.	53	200	365	36.5	4-I	8	neg.	neg.	neg.	3	0.1	neg.	neg.	neg.	neg.
Shallowford Community Hosp. 4575 N. Shallowford Rd, Chamblee, GA.	22	400	365	73	1-I	7	2.5	10	3	3	0.3	0.1	0.4	0.1	0.1
Woolworth - Woolco 1740 Peachtree Street, N.W. Atlanta	15	1,200	300	180	1	7	2.5	10	3	3	0.6	0.2	0.9	0.3	0.3
Internal Revenue Service Chamblee, GA.	21	8,000	150	600	1	7	2.5	10	3	3	2.1	0.8	3.0	0.9	0.9
Emory University Haygood Drive, N.E., Atlanta	38	3,000	260	390	1 & 4	7	2.5	10	3	3	1.4	0.5	2.0	0.6	0.6
GA. Mental Health Institute 1256 Briarcliff Road, N.E., Atlanta	38	1,000	260	130	0 & 4	7	2.5	10	3	3	0.5	0.2	0.7	0.2	0.2
Citizen's Jewelry Co. 4070 LaVista Road, Tucker, GA.	31	330	300	49.5	1	7	2.5	10	3	3	0.2	neg.	0.2	neg.	neg.
Cal-Maine Foods, Inc. 2675 Lithonia Industrial Blvd., Lithonia, GA.	55	480	312	74.9	0	7	2.5	10	3	3	0.3	0.1	0.4	0.1	0.1
McDonald's Corporation 5220 Buford Highway, Doraville, GA.	22	400	365	73	1 & 2	7	2.5	10	3	3	0.3	0.1	0.4	0.1	0.1

Table 4-2 (Continued). LIST OF NON-POINT SOURCE INCINERATORS BY COUNTY - 1975

Incinerator/Location	Grid	Refuse burned (lb/day)	Days operated per year	Refuse burned (tons/year)	Type waste	Emission Factors (lb/ton)					Emissions (tons/year)				
						Particulate	SO_x	CO	HC	NO_x	Particulate	SO_x	CO	HC	NO_x
Gene Tyner Food Store Buford Highway, Doraville, GA.	22	400	260	52	1	7	2.5	10	3	3	0.2	0.1	0.3	0.1	0.1
Decatur Hospital 450 N. Candler Road Decatur, GA.	52	1750	365	319.4	0	7	2.5	10	3	3	1.1	0.4	1.6	0.5	0.5
GEX Store 3001 N.E. Freeway, Atlanta	29	2400	310	372	0	7	2.5	10	3	3	1.3	0.5	1.9	0.6	0.6
Dekalb Co. Sanitation Dept. Camp Circle; Dekalb Co.	53	6000	175	525	4	8	neg.	neg.	neg.	3	2.1	neg.	neg.	neg.	0.8
Dekalb Co. Water & Sewer Sys. 4124 Flakes Mill Road, Decatur, GA.	79	25,000	260	3250	sewage sludge	3	0.8	neg.	1	5	4.9	1.3	neg.	1.6	8.1
Enternationals Flea Market 3655B Memorial Drive, Decatur, GA.	40	300	100	15	1	7	2.5	10	3	3	neg.	neg.	neg.	neg.	neg.
Fulton Co.															
Piedmont Hospital 1968 Peachtree Road, N.W. Atlanta	36	2500	260	325	4	8	neg.	neg.	neg.	3	1.3	neg.	neg.	neg.	0.5
Ponce de Leon Infirmary 144 Ponce de Leon Avenue Atlanta	49	5	12	0.03	4-1	8	neg.	neg.	neg.	3	neg.	neg.	neg.	neg.	neg.
Colonial Stores, Inc. 2251 Sylvan Road, East Point, GA.	64	6000	300	900	1	7	2.5	10	3	3	3.2	1.1	4.5	1.4	1.4
Eastern Airlines Hartsfield International Airport; Atlanta	82	2000	300	300	1	7	2.5	10	3	3	0.6	0.2	0.9	0.3	0.3

Table 4-2 (Continued). LIST OF NON-POINT SOURCE INCINERATORS BY COUNTY - 1975

Incinerator/Location	Grid	Refuse burned (lb/day)	Days operated per year	Refuse burned (tons/year)	Type waste	Emission Factors (lb/ton)					Emissions (tons/year)				
						Particulate	SO_x	CO	HC	NO_x	Particulate	SO_x	CO	HC	NO_x
South Fulton Hospital 1170 Cleveland Avenue East Point, GA.	76	40	365	7.3	4	7	2.5	10	3	3	neg.	neg.	neg.	neg.	neg.
South Fulton Hospital 1170 Cleveland Avenue, East Point, GA.	76	1200	365	219	3-I	7	2.5	10	3	3	0.8	0.3	1.1	0.3	0.3
City of Atlanta - PW/WPC Division 735 Selig Drive, S.W. Atlanta	33	45,000	260	5850	Sewage sludge	3	0.8	neg.	1	5	8.8	2.3	neg.	2.9	14.6
Crawford W. Long Memorial Hospital 35 Linden Avenue; Atlanta	49	10,000	360	1800	0 & 3	7	2.5	10	3	3	6.3	2.3	9.0	2.7	2.7
Grady Memorial Hospital 80 Butler Street, S. E. Atlanta	59	12,000	360	2160	1 & 4	7	2.5	10	3	3	7.6	2.7	10.8	3.2	3.2
West Paces Ferry Hospital 3200 Howell Mill Road, N.W. Atlanta	27	110	260	14.3	1 & 4	7	2.5	10	3	3	neg.	neg.	neg.	neg.	neg.
Georgia Baptist Hospital 300 Boulevard, N.E., Atlanta	49	2800	312	436.8	0-I	7	2.5	10	3	3	1.5	0.5	2.2	0.7	0.7
Northside Hospital 1000 Johnson Ferry Road, N.E., Atlanta	20	13	52	0.34	4	8	neg.	neg.	neg.	3	neg.	neg.	neg.	neg.	neg.
Southern Straw Mfg. Co. 4415 Wendell Drive, N.W., Atlanta	UNK	50	100	2.5	1	7	2.5	10	3	3	neg.	neg.	neg.	neg.	neg.
Southern Straw Mfg. Co. 4415 Wendell Drive, N.W., Atlanta	UNK	50	100	2.5	1	7	2.5	10	3	3	neg.	neg.	neg.	neg.	neg.

Table 4-2 (Continued). LIST OF NON-POINT SOURCE INCINERATORS BY COUNTY - 1975

Incinerator/Location	Grid	Refuse burned (lb/day)	Days operated per year	Refuse burned (tons/year)	Type waste	Emission Factors (lb/ton)					Emissions (ton/year)				
						Particulate	SO_x	CO	HC	NO_x	Particulate	SO_x	CO	HC	NO_x
Gwinnett Co.															
K-Way Stores of GA. 422 E. Crogan Street Lawrenceville, GA	5	1,000	312	156	0	7	2.5	10	3	3	0.5	0.2	0.8	0.2	0.2
Buford General Hospital 55 Morningside Drive Buford, GA	5	160	365	29.2	1 & 4	7	2.5	10	3	3	0.1	neg.	0.1	neg.	neg.
Joan Glancy Memorial Hosp. Box 4X Route 2, Duluth, GA	4	160	365	29.2	1 & 4	7	2.5	10	3	3	0.1	neg.	0.1	neg.	neg.
Tara Materials Lawrenceville Industrial Park: Lawrenceville, GA	5	3,000	255	382.5	0	7	2.5	10	3	3	1.3	0.5	1.9	0.6	0.6
Button Gwinnett Hospital Lawrenceville, GA	17	400	360	72	1 & 4	7	2.5	10	3	3	0.3	0.1	0.4	0.1	0.1
S & H Co. 2900 I-85 Access Road, Norcross Road	4	10,000	180	900	1	7	2.5	10	3	3	3.2	1.1	4.5	1.4	1.4
Totals				21,758 t/yr							58.3	17.4	55.5	21.1	41.4

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Table 4-3. CLASSIFICATION OF INCINERATED WASTES[a]

Type of waste		Principal components	Approximate composition, % by weight	Moisture content, %	Incombustible solids, %	BTU value, lb of refuse as fired	BTU of aux. fuel per lb of waste to be included in combustion calculations	Recommended minimum BTU in burner input per lb waste
Type	Description							
0		Combustible trash, paper, cardboard, wood, rags, etc.		10	5	8,500	0	0
1	Rubbish	Combustible waste, paper, cartons, rags wood scraps, floor sweepings, foodscraps, domestic, commercial, industrial sources	Rubbish 100% (Garbage up to 20%)	25	10	6,500	0	0
2	Refuse	Rubbish and garbage, residential sources	Rubbish 50% Garbage 50%	50	7	4,300	0	1,500
3	Garbage	Animal & vegetable wastes, restaurants, hotels, markets, institutions, commercial, and club sources	Garbage 100% (Rubbish up to 35%)	70	5	2,500	1,500	3,000
4	Animal solids and organic wastes	Carcasses, organs, solid organic wastes, hospital, laboratory, abattoirs, animal pound, and similar sources	100% animal and human Tissue	85	5	1,000	3,000	8,000 (5000 primary) (3000 secondary)
5	Gaseous, liquid or semi-liquid wastes	Industrial process wastes	variable	Dependent on predominant constituents	Variable according to wastes survey	Variable according to wastes survey	Variable according to wastes survey	Variable according to waste survey
6	Semi-solid and solid matter	Combustibles requiring hearth, retort, or grate burning equipment	"	"	"	"	"	"

[a] As defined by the Incineration Institute of America.

Source category	Total emissions (tons/year) - 1973				
	Particulate	SO_x	CO	HC	NO_x
INCINERA	58.3	17.4	55.5	21.1	41.4

Projections

There has existed a recent trend to shut down on-site incinerators and use compactors or dumpsters for commercial, institutional, and industrial solid waste disposal. However, this trend probably will moderate because all of the remaining incinerators are expected to become in compliance with air pollution control regulations and will not require expensive upgrading. Most incinerator operators probably will not change their means of waste disposal unless the economics of an alternate disposal method change or the facility moves or is renovated. Also, the possibility of new on-site incinerators exists. Therefore, it has been assumed that solid waste disposal in and emissions from on-site incinerators will remain almost constant over the next ten years at the estimated 1973 level.

Subarea Distribution

The street addresses of all the on-site incinerators are known (Table 4-2). Therefore, emissions for 1973 and succeeding projection years have been allocated directly to the appropriate grids by totaling the amount of refuse burned and resulting emissions in each grid. Thus, emissions are summarized as "additional emissions" under the INCINERA category in the Area 2 Program printouts (Appendices D - P) and total emission summaries (Tables 1, 2, 3 and 4).

FOREST FIRES AND AGRICULTURAL BURNING (FFAGBUR)

Area-wide Emissions

In 1973, 5,986 unintentional forest and grass/field fires burned 6,858 acres in the 5 county study area, according to the Georgia Forestry Commission and the various county fire departments. This acreage is approximately 60 percent pine with light forested growth predominating throughout all counties. There is no commercial thinning or prescribed burning of undergrowth; natural regeneration is maintained. An estimate obtained for the fuel consumed per forested acre under fire is 10 tons wood/acre (Ref. 39). Table 4-4 summarizes the pertinent data:

Table 4-4. FOREST/GRASS/FIELD FIRES BY COUNTY - 1973

County	No. forest fires[a]	Acres burned	No. grass/ field fires[b]	Acres burned[c]
Fulton	85	185	175[33]	175
Dekalb	25	170	1,778[34]	1,778
Cobb	72	314	1,037[35]	1,037
Clayton	87	276	317[36]	317
Gwinnett	124	320	161[37]	161
City of Atlanta	-	-	(2,125)[38]	(2,125)
Total	393	1,265	3,468[d]	3,468[d]

[a] Includes forest fires answered by the Georgia Forestry Commission, mostly in unincorporated areas (Ref. 40).

[b] Includes grass/field fires answered by county fire deparments, in unincorporated county areas only, except for City of Atlanta.

[c] No data available. Computed as 1/3 (acres burned/fire) that prevailed for forest fires (3.2 acres/fire); therefore, = 1 acre/fire (Ref 39).

[d] Does not include Atlanta totals.

The actual computation of emissions was carried out in 2 parts - emissions from fires occurring predominately in unincorporated areas of the counties and emissions from fires within the city limits of Atlanta. This was necessary due to the different apportioning techniques appropriate for each. As was the case with open burning, it was unfeasible to attempt to acquire data specific to the large number of incorporated cities and towns for inclusion herein. Therefore, Atlanta is the only city for which data was treated.

1) FFAGBUR (Unincorporated County):

Total fires = 3,861; total acres destroyed = 4,733

Total fuel consumed (tons/year) = (4,733 acres)(10 tons/acre)

= 47,330 tons/year

Emission factors for this subcategory (AP-42) are tabulated in Table A-1 and were input to the Area 2 Program along with the above fuel total to calculate total and apportioned emissions.

2) FFAGBUR (City of Atlanta):

Total fires = 2,125; total acres destroyed = 2,125

Total fuel consumed = (2,125 acres)(10 tons/acre)

= 21,250 tons/year

Emission factors for this subcategory are identical to those for the above subcategory, but were not input with the fuel total to the Area 2 Program for apportioned emission calculation. Total emissions for both subcategories are shown below:

Source category	Total emissions (tons/year) - 1973				
	Particulates	SO_x	CO	HC	NO_x
FFAGBUR (Unincorporated county)	402.3	0.0	2366.5	473.3	47.3
FFAGBUR (City of Atlanta)	180.6	0.0	1062.5	212.5	21.3
Totals	582.9	0.0	3429.0	685.8	68.6

Subarea Distribution

Allocation of emissions from FFAGBUR in unincorporated counties to grid cells was done by the Area 2 Program proportional to the forested acreage per grid. The total forested watershed acreage per county, exclusive of cropland, populated, or highway acreage, was obtained from the Georgia Forestry Commission (Ref. 39). The forested acreage for each grid was estimated from USGS maps. These estimates were subsequently totalled by county and forced to fit the actual county totals.

Since estimates of forested or grass/woods covered acreage within the city limits of Atlanta were impossible to obtain, the emission totals were distributed evenly among the 36 grid cells constituting the city proper, and thus, had to be separated from the apportioning part of the program. The affected grids are: 27, 28, 33, 34, 35, 36, 37, 41, 42, 43, 44, 46, 47, 48, 49, 50, 51, 52, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 70, 71, 74, 75, 76, 77, 81, 82.

Projections

Climatic factors will heavily influence the occurence of unintentional forest and field fires on a year to year basis and predicting future trends is quite difficult. Emissions

from this category, however, may decline as suburban development encroaches on heretofore undeveloped forested land. Based upon total population increases in the unincorporated areas of the counties containing grids with forested acreage, the acreage burned for each projection year was adjusted downward by a factor equal to the product of the percent population increase and the ratio of the urban to the forested area.

Year	1973	1975	1980	1985
Population of grids in unincorporated areas of counties containing forested acreage	584,021	679,455	867,905	1,174,356
Growth factor	base	1.16	1.49	2.01
Adjusted growth factor	base	0.96	0.87	0.74
FFAGBUR (unicorporated counties) fuel usage (tons/year)	47,330	45,437	41,177	35,024

Considering the Atlanta sector of this category, it is noted that there is an overall projected decline in population from 1973 to 1985 among the 36 grids constituting the city. This is consistent with trends projected for most cities in that as urban centers develop, less space exists for residential use. Although it has been postulated that tight energy use policies may well reverse this trend; nevertheless, it was assumed that as population decreased in this sector, however slight, emissions decreased proportionately.

Year	1973	1975	1980	1985
Population of 36 grids constituting city of Atlanta	520,323	518,803	492,220	504,371
Growth factor	base	0.997	0.946	0.97
FFAGBUR (City of Atlanta) fuel consumed (tons/year)	21,250	21,186	20,103	20,613

5. OTHER SOURCES

EVAPORATIVE LOSS SOURCES (EVAPLOS)

Area-wide Emissions

This category considers emissions from gasoline handling losses, dry cleaning losses, and surface coating and miscellaneous solvent-use operations. No local survey data was available to estimate HC losses from these sources; therefore, procedures outlined in Reference 1 were employed.

1. Solvent Use:

Emissions were computed under this subcategory for dry cleaning operations only. From the per-capita emission factor given in Reference 1 and the per ton emission factor presented in Reference 11, a per-capita use factor was developed, due to the necessity, when using the Area 2 Program, to enter the fuel usage total and emission factor in compatible units.

$$\text{Per capita use factor} = \frac{2 \text{ lb HC emitted}}{\text{capita-year}} \Big/ 257.5 \frac{\text{lb HC emitted}}{\text{ton solvent used}}$$

$$= 15.5 \frac{\text{lb solvent used}}{\text{capita-year}}$$

Solvent use emissions for the 5 county region in 1973 are:

Solvent used (tons/year) =

$$\frac{(1{,}522{,}800)\left(\frac{15.5 \text{ lb solvent}}{\text{cap.-yr}}\right)}{2{,}000 \text{ lb/t}} = \underline{11{,}802 \text{ tons/yr}}$$

The emission factor for this subcategory is the average of the published (AP-42) factors for petroleum and synthetic solvents - 257.5 lb/t.

2. Surface Coating Operations:

The per-capita solvent use factor - 28 $\frac{\text{lb solvent used}}{\text{capita-year}}$ (Ref. 11) was used to calculate total solvent use:

$$\text{Solvent used (tons/year)} = \frac{(1{,}522{,}800)(28 \frac{\text{lb solvent used}}{\text{capita-year}})}{2{,}000 \text{ lb/ton}}$$

$$= 21{,}319 \text{ tons/year}$$

The emission factor for this subcategory is the average of the factors for 5 surface coatings - 1,164 lb/ton (AP-42).

3. Gasoline Handling Losses:

The splash filling and liquid spillage losses associated with the filling of motor vehicle gas tanks were the only emission sources considered under this subcategory. Emissions from petroleum storage tanks were assumed to have been accounted for by point source inventories.

From county fuel sales reports for 1973 (Ref. 18), gasoline usage is:

Total on-highway gasoline consumption = $886{,}052 \times 10^3$ gal/year
Total off-highway gasoline consumption = $+20{,}786 \times 10^3$ gal/year
Total gasoline usage in study area = $906{,}838 \times 10^3$ gal/year

$$= \frac{(906{,}838 \times 10^3 \text{ gal/year})(6.17 \text{ lb/gal})}{(2{,}000 \text{ lb/t})}$$

$$= 2{,}797{,}595 \text{ tons/year}$$

It is assumed that all the gasoline sold in the area but not consumed there equals that sold elsewhere but consumed in the area.

The emission factor for this subcategory equals:

$$EF = 11.0 \text{ lb}/10^3 \text{ gal pumped (vapor displacement loss)}$$
$$\underline{+0.67 \text{ lb}/10^3 \text{ gal pumped (liquid spillage loss)}}$$
$$= 11.67 \text{ lb}/10^3 \text{ gal pumped}$$

Converting units:

$$EF = (11.67 \text{ lb}/10^3 \text{ gal})\left(\frac{10^3 \text{ gal}}{3.1 \text{ T}}\right) = \underline{3.8 \frac{\text{lb HC emitted}}{\text{ton gas pumped}}}$$

The overall emission factor for this category is a weighted average of the factors for the above 3 subcategories, since a combined input to the Area 2 Program was desirable. Its derivation follows:

$$\overline{EF} = \frac{(11{,}802)(257.5)+(21{,}319)(1{,}164)+(2{,}797{,}595)(3.8)}{(11{,}802 + 21{,}319 + 2{,}797{,}595)}$$

$$= \underline{13.6 \frac{\text{lb HC emitted}}{\text{T solvent used}}}$$

Total hydrocarbon emissions from evaporative loss sources equal:

Source category	HC emissions (tons/year) - 1973
Solvent use	1,520
Surface coating	12,408
Gasoline handling	5,315
Total	19,243

Projections

It is not anticipated that solvent usage rates will fluctuate greatly during the period of accountability of this study. It always remains a possibility, however, that more refined control measures will be implemented for this essentially uncontrolled category. In the absence of more sophisticated estimation techniques, projections for all evaporative loss sources are based solely on the total population increase in the 5 county study area (Ref. 31). Projected solvent/gas usage and corresponding EVAPLOS emissions are:

Year	1973	1975	1980	1985
Total population	1,522,800	1,612,725	1,887,782	2,209,845
Growth factor	base	1.06	1.24	1.45
Solvent/gas usage (tons/year)	2,830,716	3,000,559	3,510,088	4,104,538
Total HC emissions (tons/year)	19,243	20,398	23,861	27,902

Subarea Distribution

Emissions were distributed to grid cells proportional to the total population of the cells during the respective study year (Appendices D through P).

FUGITIVE DUST-UNPAVED ROADS (FDUNPRD)

Area-wide Emissions

There were 1,441.9 miles of unpaved roads in the 5 county region reported in the 1973 inventory of roads prepared by the Georgia DOT (Ref. 41). Gwinnett County contained the greatest number with 636.5 and Clayton, the fewest, with 87.1. Fulton, Dekalb, and Cobb had 251.5, 200.4, and 266.4, respectively. From official highway maps and USGS topographic maps, however, the location of only 472 miles of these roads could be determined. It is highly probable that the DOT inventory is accurate and the balance of the mileage is not accounted for on USGS maps because the most recent survey data have not yet been incorporated thereon. Also unaccounted for may be city alleys and roads in outlying residential developments that are not paved until construction is complete. Nevertheless, for apportioning purposes, it was assumed that the actual complement of unpaved road mileage per grid was in the same proportion to those values actually determined from USGS maps.

Transportation department personnel provided a state-wide estimate of average daily traffic (ADT) on county locally controlled roads - both paved and unpaved - of 94 vehicles/day (Ref. 41). The estimated ADT on unpaved roads alone was unavailable. Therefore, it was concluded that this estimate would unrealistically represent the ADT on unpaved roads, tending to more heavily weight the paved surfaces, by virtue of their greater number. Therefore, a figure of 23 vehicles/day, derived from estimates compiled by the Utah State Department of Highways (Ref. 42) was used. This value represents ADT on non-surfaced roads in 5 counties in the Salt Lake City area. This was judged a reasonable estimate, in that it was derived for an area similar to Atlanta in terrain features, road types, vehicle mix, and population distribution.

The annual VMT then, is:

$$\text{VMT (annual)} = (23 \text{ veh/day})(1{,}442 \text{ mi roads})(365)$$
$$= \underline{12{,}106 \times 10^3 \text{ VMT/yr}}$$

The emission factor for unpaved roads was obtained from the EPA report, Development of Emission Factors for Fugitive Dust Sources (Ref. 43), assuming a gravel roadbase with an average silt content of 12 percent, and an average speed of 30 mph on the roads.

$$\text{EF (unpaved roads)} = 0.81\, s\left(\frac{S}{30}\right) = 0.81(12)\left(\frac{30}{30}\right)$$
$$= 9.72 \text{ lb/VMT}$$

This value was corrected downward to account for the relative climatic factors between the area in which the factor was developed and Atlanta, and by the annual percentage of time during which no emissions would occur because of rainfall, to yield a revised emission factor of 2.04 lb/vehicle-mile traveled.

The correction factor derivations are:

Climatic factor:

C_1 (Franklin County, Kansas) = 0.1 (Ref. 43, pp. 47)
C_2 (Atlanta) = 0.03 (Ref. 43, pp. 47)
C (relative) $= C_2/C_1$ = 0.3

Surface moisture:

No. days with >0.01 in. precipitation = 110 (Ref. 43, pp. 132)

$$\text{EF (unpaved roads)}_{\text{corrected}} = (9.72 \text{ lb/VMT})(0.3)\left(\frac{365-110}{365}\right)$$
$$= 2.04 \text{ lb/VMT}$$
$$= \underline{2{,}040 \text{ lb}/10^3 \text{ VMT}}$$

The resulting area-wide emissions were then calculated and apportioned by the Area 2 Program.

$$\text{FDUNPRD Emissions} = (12{,}106 \times 10^3 \text{ VMT/yr})(2{,}040 \text{ lb}/10^3 \text{ VMT})\left(\frac{\text{ton}}{2000 \text{ lb}}\right)$$

$$= \underline{12{,}348 \text{ ton/year}}$$

Projections

As indicated above, there is almost no information available on present traffic volumes on the unpaved roads, much less data on discernible trends toward increased or reduced traffic volumes. Nevertheless, observations can be made regarding certain classifications of unsurfaced roads, leading to the conclusion that the total VMT may remain constant over the next 10 years.

First, most of the county maintained unpaved roads lead to rural residences, farming districts, or recreational areas and forested land. Therefore, volume on these roadways is unlikely to increase proportionately with total traffic volume for the counties. Secondly, if traffic on a road were to increase significantly as a result of a new trip generator along the road, the road would probably be paved at that time. Thirdly, roads in new residential areas that are to be paved by developers when building construction phases are completed will be replaced by similar under-construction developments in future years.

For lack of any definitive information, it has been assumed that traffic volume on unpaved roads will remain constant over the next 10 years, with the total mileage of unpaved roads decreasing by about 5 percent annually. (Ref. 41).

Projections then, are:

Year	1973	1975	1980	1985
% 1973 unpaved roads remaining	100	90	65	40
Annual VMT ($x10^3$)	12,106	10,895	7,869	4,842
FDUNPRD emissions (tons/year)	12,348	11,113	8,026	4,939

Subarea Distribution

All fugitive dust emissions from unpaved roads were allocated directly to grid cells based on the measured mileage of unpaved roads contained in each.

FUGITIVE DUST - PAVED ROADS (FDPAVRD)

Area-wide Emissions

Initially, inclusion of this source category in the area source inventory was not intended, due to the paucity of available data and procedures on which to base emission estimates. However, this source is becoming recognized as a significant contributor to the total particulate loading in many areas, and it was concluded that some quantitative estimate should be included, in spite of the paucity of pertinent data.

It must be emphasized that the derivations presented below do not have the same accuracy as calculations in other sections of this report, and the resulting emission estimates are only order-of-magnitude values. In recognition of this and in anticipation of future refinements of these estimates, this source category has been separated from the remainder of the categories in all data summaries.

Seattle Study - Only one study was found in which any pertinent data have been published (Refs. 44, 45). From a single test of a paved road that was flushed and swept regularly, field sampling showed an emission rate of 0.14 lb/VMT, with 0.0055 lb/VMT (2.5 grams/VMT) below 10 micrometers in size. Three tests of dusty paved roads, in areas with construction projects or near unpaved roads where dirt was tracked onto the pavement, indicated an average emission factor of 0.83 lb/VMT with 0.17 lb/VMT (77 grams/VMT) under 10 micrometers.

A major concern with these reported values is the sampling method used--impaction samplers were mounted in an array on a trailer towed behind the test vehicle. Most of the

resuspended material collected in the area of turbulence on the roadway would have an impact on air quality only in this limited area and not on a regional scale. This sampling method does not allow for settling and, more importantly, it may pick up particulate matter generated by many preceding vehicles, not just the test vehicle.

Example emission calculations presented in an appendix to the publication (Ref. 44, Appendix 4) show substantial reductions from the emission rates cited above, although these reductions are not made for the purpose of compensating for the sampling method. In calculating annual emissions, the authors assume that:

1. dust is emitted from the road 200 days/year (in Seattle);
2. the "dry emission factor" is 30% less than the values presented;
3. average dusty paved roads emit at only 50 % of the rate for the three roads tested; and
4. the sample of under 10 microns is comparable to the suspended particulate emitted.

No data are presented to support any of these assumptions.

If the emission factors and assumptions from this study are applied to Atlanta data, and it is additionally assumed that roads in Atlanta would be similar to the tested street that was cleaned regularly, the following results are obtained:

$$EF \text{ (corrected)} = (0.0055 \text{ lb/VMT})(0.7)\left(\frac{255}{365} - \frac{\text{days with}}{\text{no rain}}\right)\left(\frac{10^6}{10^6}\right)$$

$$= \underline{2{,}690 \text{ lb}/10^6 \text{ VMT}}$$

The 50% correction factor was not used, since it applied specifically to uncleaned streets.

Thus, total emissions are:

$$\text{FDUNPRD Emissions} = (11{,}208 \times 10^6 \text{ VMT/yr})(2{,}690 \text{ lb}/10^6 \text{ VMT})\left(\frac{\text{ton}}{2{,}000 \text{ lb}}\right)$$

$$= \underline{15{,}075 \text{ ton/year}}$$

Of course, the total VMT traveled and the EF were input to the Area 2 Program to calculate apportioned emissions (Appendices D through P).

Chicago Study - The American Public Works Association (APWA) is presently conducting a study to determine the environmental benefits of improved street cleaning. In conjunction with the Chicago Department of Environmental Control and IIT Research, they are microscopically examining hi-vol filters from street canyon exposures in an attempt to determine the origin of the particulate matter. They have not yet reached final conclusions, but preliminary indications (Ref. 46) are that auto exhaust accounts for only 25 percent of motor vehicle impact, with the remainder from resuspended dust and tire wear. Using this 25 percent factor and particulate emission factors from Chapter 3, an average emission factor for the road dust portion can be approximated:

(0.25)(TMVPEF)*	=	0.34 grams/VMT
TMVPEF	=	1.36 grams/VMT
FDPAVRD	=	TMVPEF - exhaust - tire wear - brake wear
	=	1.36 - 0.34 - 0.20 - 0.02
	=	0.8 grams/VMT

With this factor, fugitive dust from paved roads in Atlanta would equal 9875 ton/year. For an initial estimate, it is

* Total motor vehicle particulate emission factor.

proposed that the value from the Seattle Study be used in order to pressure the "worst case" analysis.

Projections

At this point, it cannot even be established that VMT is the best indicator of dust emissions from paved roads. Emissions are possibly more closely related to miles of road surface or some other parameter. However, since the current emission estimates are based on VMT, future emissions can reasonably be assumed to increase proportionately to VMT. These emissions are:

Year	1973	1975	1980	1985
Estimated total VMT ($x10^6$)	11,208	11,794	14,275	15,568
Growth factor	base	1.05	1.27	1.39
FDPAVRD emissions (ton/year)	15,075	15,863	19,200	20,939

Subcounty Distribution

To maintain consistency, dust emissions from paved roads have been allocated based upon the total VMT in each grid for the study years. The distributions of estimated emissions from dust on paved roads are shown in Appendices D through P.

FUGITIVE DUST - AGRICULTURAL TILLING (FGDAGTIL)

Area-wide Emissions

Windblown dust from tilled fields was estimated by use of the wind erosion equation, a procedure explained in detail in Reference 43. Briefly, a separate emission factor is established for each crop type in an area as a function of resistance to wind erosion provided by that crop and plowing methods normally used with it. The emission factors also vary according to the common soil types found in agricultural land in an area and its climate. The fugitive dust component generated by the actual implement tilling operation has also been estimated.

Emission calculations for tillage operations account for the limited periods when the farming equipment is actually used in the fields; they do not account for the lower level emissions that occur periodically as a result of wind erosion across the fields. Annual emissions from tilling may be quite small in comparison with suspended particulate emissions generated by wind erosion.

The total acreage devoted to harvested cropland in the 5 county region in 1973 was 4,690 acres (Ref. 47), consisting of cotton, soybeans, corn, and wheat. The acreage harvested by small truck farms and other sources was considered negligible, as was acreage devoted to hay, since data pertaining to these categories was unobtainable.

The modified form of the wind erosion equation is:

$$E_w \text{ (tons/acre/year)} = aICKL'V' (\pm 5\%) \qquad \text{(Ref. 43)}$$

where,

a, I, C, K, L', V' are quantities and factors defined in Table 5-1, in which windblown dust emissions from the tilled acreage in the 5 counties are presented in tabular form. The total particulate emissions from the windblown component are seen to be 35.1 ton/year.

The emission factor for tillage operations is estimated by the following equation:

$$E_t \text{ (lb/acre)} = \frac{1.4s(S/5.5)}{(PE/50)^2} \quad (\pm 15\%) \quad \text{(Ref. 43)}$$

where,

S = implement speed (mi/hr) - assumed to be 5.5 mph

s = silt content of soil (%) - assumed to be 10%

PE = thornthwaite's precipitation-evaporation index = 118 for the study area (Ref. 43)

The calculated tillage EF then, was 2.5 lb/acre. Fugitive dust emissions by county then were calculated:

County	Acres tilled	X	EF(lb/acre)	X	No. tillings per year	X	T/2,000 lb	=	FD. emissions (tons/year)
Fulton	970		2.5		3		T/2,000 lb		3.6
Dekalb	150		2.5		3		T/2,000 lb		0.6
Cobb	500		2.5		3		T/2,000 lb		1.9
Clayton	620		2.5		3		T/2,000 lb		2.3
Gwinnett	2450		2.5		3		T/2,000 lb		9.2
Total	4690								17.6

The total fugitive dust emissions from agricultural activity are presented below by county:

Table 5-1. FUGITIVE DUST EMISSIONS FROM AGRICULTURAL FIELDS DUE TO WIND EROSION - 1973

County	Crop	A, acres	L, field length	V, vegetative cover	I(T/ac-yr), based on soil type	C, climatic factor	K, surface roughness	L', length factor	V', vegetative factor	E = AaICKL'V'* windblown dust emissions by crop (tons/year)
Fulton	cotton	50	2000/2	250			0.5	0.65	0.58	0.6
	soybeans	200	2000/2	250			0.6	0.70	0.58	3.1
	corn	650	2000/2	500	86	0.03	0.6	0.70	0.20	3.5
	wheat	70	2000/2	1350			0.6	0.70	0.00	neg.
									Total	7.2
Dekalb	corn	150	2000/2	500	86	0.03	0.6	0.70	0.20	0.8
									Total	0.8
Cobb	corn	500	2000/2	500	86	0.03	0.6	0.70	0.20	2.7
									Total	2.7
Clayton	corn	400	2000/2	500			0.6	0.70	0.20	2.2
	soybeans	120	2000/2	250	86	0.03	0.6	0.70	0.58	1.9
	wheat	100	2000/2	1350			0.6	0.70	0.00	neg.
									Total	4.1
Gwinnett	cotton	350	2000/2	250			0.5	0.66	0.58	4.3
	soybeans	500	2000/2	250			0.6	0.70	0.58	7.9
	corn	1500	2000/2	500	86	0.03	0.6	0.70	0.20	8.1
	wheat	100	2000/2	1350			0.6	0.70	0.00	neg.
									Total	20.3
									Study area total	35.1

* where a = portion of total wind erosion losses that would be measured as suspended particulate, estimated to be 0.025.

Table 5-2. TOTAL EMISSIONS FROM AGRICULTURAL ACTIVITY - 1973

County	Acres tilled	Emissions from implement tilling operations (tons/year)	Emissions from wind erosion- from Table 5-1 (tons/year)	Total agricultural associated emissions (tons/year)
Fulton	970	3.6	7.2	10.8
Dekalb	150	0.6	0.8	1.4
Cobb	500	1.9	2.7	4.6
Clayton	620	2.3	4.1	6.4
Gwinnett	2,450	9.2	20.3	29.5
Totals	4,690	17.6	35.1	52.7

Subarea Distribution

From information contained in Reference 47 and USGS quadrangle maps, the grid cells most likely to contain agricultural activity were estimated to be Nos.: 1, 2, 3, 4, 8, 15, 16, 17, 24, 55, 87, 88, 91, 92, 93. These grids were grouped by county and the total emissions by county divided among them equally and added to the Area 2 Program as "Additional Emissions."

Projections

In the years ahead, the state expects a 30 percent increase in soybeans harvested and a 5 percent increase in corn, although much less for the urbanized counties under study here (Ref. 48). However, a decrease in total acreage harvested is also forecast as urban land development encroaches further into traditional farm areas.

Quantitative projected estimates specific to the counties under study could not be obtained, but subjective indications were translated into a 10 percent reduction of total harvested acreage between 1975 and 1980 followed by another 10 percent by 1985, with the 1975 harvested acreage equalling that of 1973. Projected and distributed particulate emissions are summarized as follows:

County	Grids	Total emissions (tons/year) '73/'75/'80/'85	Grid emissions (tons/year) '73/'75/'80/'85
Fulton	3,4,87,88	10.8/10.8/9.7/8.6	2.7/2.7/2.4/2.2
Dekalb	55	1.4/1.4/1.3/1.1	1.4/1.4/1.3/1.1
Cobb	1,2,8,24	4.6/4.6/4.1/3.7	1.2/1.2/1.1/1.0
Clayton	91,92,93	6.4/6.4/5.8/5.1	2.1/2.1/1.9/1.7
Gwinnett	15,16,17	29.5/29.5/26.6/23.6	9.8/9.8/8.8/7.8

The total predicted emissions are 52.7 tons/year in 1975, 47.4 tons/year in 1980, and 42.2 tons/year in 1985.

FUGITIVE DUST - CONSTRUCTION (FGDCONST)

Area-wide Emissions

For purposes of estimating emissions, three different types of construction were identified: commercial/industrial/ institutional, residential, and highway. However, data was available pertaining to the first category only.

A list of commercial construction projects in the 5 county region in 1973 was obtained from the Atlanta Chamber of Commerce (Ref. 49). This list included the square footage, and usage for each building project, but did not include the street address of each : the total acreage disturbed by construction. After repeated attempts to obtain this and additional data, it was necessary to make a number of assumptions in order to treat the data meaningfully. General guidelines have been adopted from The Community Builder's Handbook (Ref. 50). The assumptions follow, and form the basis for derivation of the quantities presented in Table 5-3.

1) Office buildings: with 128 bldgs (8,409,064 ft^2); have ~66,000 ft^2/bldg. Assume 6 floors per bldg @ ~ 10,000 ft^2/floor, and 2 x (ground floor ft^2) land area is disrupted or 20,000 ft^2/bldg(0.5 acre) exposed to construction.
2) Office Parks: with 65 bldgs. (3,123,629 ft^2); have ~ 48,000 ft^2/bldg. Assume 3 floors/bldg @ ~ 16,000 ft^2/ floor, and 4 x (ground floor ft^2) land area is disrupted or 64,000 ft^2/bldg(1.5 acre) exposed to construction.
3) Warehouses, Mfg. Plants, Retail Stores, Terminals, Other: Assume all are 1 floor construction and 2 x (project ft^2) land area is exposed to construction.
4) High Rise Apts, Hospitals, Hotels/Motels: Assume 1 hotel/motel room requires 500 ft^2 plot size; 1 hospital bed requires 200 ft^2 plot size; and 1 apt. requires 1000 ft^2 plot size (Ref. 50).

Table 5-3. BUILDING CONSTRUCTION AND EMISSIONS IN THE STUDY AREA (1975)

Project type	No. bldgs.	Size of projects (ft^2)	Size of projects (acres)	Land area exposed to construction (acres)	Fugitive dust emissions (tons/year
Office buildings	128	8,409,064	193	64	89.6
Office parks	65	3,123,629	72	98	137.2
Warehouses	136	10,093,538	232	464	649.6
Mfg. plants	28	2,463,000	57	114	159.6
Retail stores	5	678,704	16	31	43.4
Hi-rise apts.	6	658,000 (658 units)	15	15	21.0
Hospitals	3	124,000 (620 beds)	3	3	4.2
Hotels/motels	19	2,193,000 (4,386 rooms)	50	50	70.0
Terminals	1	35,000	1	2	2.8
Other	-	1,322,660	31	62	86.8
Totals	391	29,100,595	670	903	1,264.2

Additionally, it was assumed that construction on all project types lasted the entire year.

The average emission factor for construction was derived from Reference 43 by adjusting the base emission rate of 1.2 tons/acre/month by a correction factor to reflect the difference in soil type and climate between the test sites and Atlanta (Ref. 43). This factor was

$$\frac{(\text{percent silt content of soil})^2}{(\text{Thornthwaite's precipitation - evaporation index})^2}$$

$\frac{(30)^2}{(95)^2}$ = 0.099, and the resulting emission factor was 1.4 tons/acre/year of active construction.

Derivation: 1.2 tons/acre/month x 12 months/year x (.099)
= 1.4 tons/acre/year

The emissions for each identified type of construction are shown in Table 5-3, producing estimated total building construction emissions of 1,264 tons/year in 1973.

Subarea Distribution

It has been pointed out that data to indicate the exact location of each of the building construction projects reported (Ref. 49) was unobtainable. Therefore, based on subjective determinations of urban activity and expansion, emissions were allocated uniformly to 47 grids bounded by the I-285 beltway, or: $\frac{1264.2}{47}$ = 26.9 tons/year/grid. The affected grids are numbers, 20, 21, 22, 26, 27, 28, 29, 30, 33, 34, 35, 36, 37, 38, 39, 41, 42, 43, 44, 46, 47, 48, 49, 50, 51, 52, 53, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 70, 71, 74, 75, 76, 77, 81, 82. Grid emissions were

input tc the Area 2 Program as "Additional Emissions." The allocation process was on the basis of grid population distribution grids were selected to have approximately equal population.

Projections

The U.S. Department of Commerce, Bureau of Economic Analysis has prepared growth projections for major U.S. metropolitan areas and AQCR's (Ref. 12). One of the categories is annual contract construction earnings. Historical data were reported for the Atlanta area for 1970 and projections for 1975, 1980, and 1985. Growth factors were developed as a ratio of $\frac{\text{future year earnings}}{\text{1973 earnings}}$ and emissions projected accordingly.

Year	1970	1973	1975	1980	1985
Contract construction earnings (10^6 1967 $)	300	(interpolated) 355	391	508	631
Growth factor	-	base	1.10	1.43	1.78
Total emissions (tons/year)	-	1,264	1,390	1,808	2,250
Grid emissions (tons/grid-year)	-	26.9	29.6	38.5	47.9

REFERENCES

1. Guide for Compiling a Comprehensive Emission Inventory, U.S. Environmental Protection Agency, Publication No. APTD-1135, Research Triangle Park, North Carolina, March, 1973.

2. 1970 Census of Housing, Detailed Housing Characteristics, HC-B series, U.S. Department of Commerce, Bureau of the Census, Washington, D.C., 1970.

3. 1960 Census of Housing, Volume I - States and Small Areas, U.S. Department of Commerce, Bureau of the Census, Washington, D.C., 1960.

4. Local Climatological Data, Atlanta, Georgia - 1973, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Environmental Data Service, 1973.

5. Mineral Industry Surveys, Bituminous Coal and Lignite Distribution, Calendar Year 1973, U.S. Department of the Interior, Bureau of Mines, Washington, D.C., April, 1974.

6. Personal Communication: Mrs. Dorothy Federoff, U.S. Bureau of Mines, and N. S. Walsh, PEDCo-Environmental Specialists, Inc., May 14, 1975.

7. "NEDS SCC Point Source Printout, Georgia State," Georgia. Department of Natural Resources, Atlanta, Georgia, 1973.

8. "Scenario A Summary," Atlanta Regional Commission, Atlanta, Georgia, January 31, 1975.

9. Employment and Earnings, Department of Commerce, Bureau of Labor Statistics, Washington, D.C., January, 1975.

10. County and City Data Book, U.S. Department of Commerce, Bureau of the Census, Washington, D.C., 1972.

11. Compilation of Air Pollutant Emission Factors, (incorporating revisions through Supplement 5), U.S. Environmental Protection Agency, Publication No. AP-42, Research Triangle Park, North Carolina, April, 1975.

12. Projections of Economic Activity for Air Quality Control Regions, U.S. Department of Commerce, Bureau of Economic Analysis, Environmental Protection Agency, Research Triangle Park, North Carolina, August, 1973.

13. Mineral Industry Surveys, Sales of Fuel Oil and Kerosene: 1973, U.S. Department of the Interior, Bureau of Mines, Washington, D.C., 1974.

14. Personal Communication: Mr. James Tate, Atlanta Gas Light Co. - Public Relations Department, and N. S. Walsh, PEDCo-Environmental Specialists, Inc., April 30, 1975, May 14, 1975 and June 23, 1975.

15. Mineral Industry Surveys, Natural Gas Production and Consumption: 1973, U.S. Department of the Interior, Bureau of Mines, Washington, D.C., 1974.

16. Mineral Industry Surveys, Sales of Liquified Petroleum Gases and Ethane: 1973, U.S. Department of the Interior, Bureau of Mines, Washington, D.C., 1974.

17. Highway Statistics, U.S. Department of Transportation, Federal Highway Administration, Washington, D.C., 1973.

18. Personal Communication: Mr. Chan Koch, Georgia State Department of Revenue, and Mr. Edwin Pfetzing, PEDCo-Environmental Specialists, Inc., April 3, 1975.

19. Personal Communication: Mr. W. Glenn Scarborough, Georgia State Department of Transportation, Atlanta Area Planning, and Mr. Edwin Pfetzing, PEDCo-Environmental Specialists, Inc., April 3, 1975.

20. Climatological Summary, U.S. Department of Commerce, Weather Bureau, Station - Atlanta, Georgia, 1973.

21. FAA Air Traffic Activity, U.S. Department of Transportation, Federal Aviation Administration, Washington, D.C., 1973.

22. Military Air Traffic Activity Report, U.S. Department of Transportation, Federal Aviation Administration, Washington, D.C., 1973.

23. Personal Communication: Mr. Gordon Jackson, Spies Associates, and Mr. N. S. Walsh, PEDCo-Environmental Specialists, Inc., June 2, 1975.

24. Official Airline Guide, A Reuben H. Donnelley Publication, Oak Park, Illinois, June, 1975.

25. Southern Region Aviation System Plan - FAA, 1975-1984, Department of Transportation, Federal Aviation Administration, Atlanta, Georgia, 1975.

26. Personal Communication: Mr. David Benson, Georgia Public Service Commission, Office of Planning, and Mr. N. S. Walsh, PEDCo-Environmental Specialists, Inc., May 8, 1975.

27. Official Railway Guide, Association of American Railroads, Intermodal Publishing Co., New York, New York, 1974.

28. Personal Communication: Mrs. Christine Hull, Georgia Department of Natural Resources, Boat Registration Division, and Mr. N. S. Walsh, PEDCo-Environmental Specialists, Inc., May 16, 1975.

29. Statistical Abstract of the United States, U.S. Department of Commerce, Bureau of the Census, Washington, D.C., 1974.

30. Personal Communication: Mr. Vic Smith, and Mr. Jim Hardee, Army Corps of Engineers, Savannah District Office, and Mr. N. S. Walsh, PEDCo-Environmental Specialists, Inc., May 22, 1975.

31. "Summary of Water Demand and Wastewater Generation Methodology and EMPIRIC Activity Allocation Model," Atlanta Regional Commission, Atlanta, Georgia, August, 1974.

32. County Business Patterns, U.S. Department of Commerce, Bureau of the Census, Washington, D.C, 1972.

33. Personal Communication: Capt. Emerson, Red Oak Fire Station (Fulton Co.), and Mr. N. S. Walsh, PEDCo-Environmental Specialists, Inc., May 15, 1975.

34. Personal Communication: Chief Guerry, Dekalb County Fire Prevention Bureau, and Mr. N. S. Walsh, PEDCo-Environmental Specialists, Inc., May 15, 1975.

35. Personal Communication: Personnel at Cobb County Fire Marshall's Office, and Mr. N. S. Walsh, PEDCo-Environmental Specialists, Inc., May 13, 1975.

36. Personal Communication: Personnel at Clayton County Fire Headquarters, and Mr. N. S. Walsh, PEDCo-Environmental Specialists, Inc., May 12, 1975.

37. Personal Communication: Personnel at Gwinnett County Fire Prevention Bureau, and Mr. N. S. Walsh, PEDCo-Environmental Specialists, Inc., May 14, 1975.

38. Personal Communication: Lt. Daniel, Atlanta Fire Prevention Bureau, and Mr. N. S. Walsh, PEDCo-Environmental Specialists, Inc., May 8, 1975.

39. Personal Communication: Mr. Garland Nelson, Georgia Forestry Commission - 3rd District, and Mr. N. S. Walsh, PEDCo-Environmental Specialists, Inc., May 21, 1975.

40. Personal Communication: Mr. Turner, Georgia Forestry Commission Headquarters - Forest Protection Department, and Mr. N. S. Walsh, PEDCo-Environmental Specialists, Inc., May 16, 1975.

41. Personal Communication: Mr. Joe Lindsay, Georgia Department of Transportation - Road Life Division, and Mr. N. S. Walsh, PEDCo-Environmental Specialists, Inc., May 8, 1975 and May 20, 1975.

42. Personal Communication: Mr. Lester Jester, Utah State Department of Highways - Systems Planning Division, and Mr. Tony Wisbith, PEDCo-Environmental Specialists, Inc., June 4, 1975.

43. Development of Emission Factors for Fugitive Dust Sources, U.S. Environmental Protection Agency, Publication No. 450/3-74-037, Research Triangle Park, North Carolina, June, 1974.

44. Roberts, J.W. et al, "The Measurement, Cost and Control of Traffic Dust in Seattle's Duwamish Valley," Paper No. AP-72-5, Presented at the APCA Pacific Northwest International Section Annual Meeting, Eugene, Oregon, November, 1972.

45. Roberts, J. W. and H. A. Watters, "Cost and Benefits of Road Dust Control in Seattle's Industrial Valley," Presented at the 67th Annual Meeting of APCA, Denver, Colorado, June, 1974.

46. Personal Communication: Mr. Ken Axetell, PEDCo-Environmental Specialists, Inc., and Mr. William J. Murphy, APWA, March 19, 1975.

47. Georgia Agricultural Facts: 1964-1972, U.S. Department of Agriculture, Statistical Reporting Service; Georgia Crop Reporting Service, Athens, Georgia, September, 1973.

48. Personal Communication: Mr. Mike Hammer, U.S. Department of Agriculture, Statistical Reporting Service, and Mr. Tom Bertke, PEDCo-Environmental Specialists, Inc., May 30, 1975.

49. "Atlanta: Major Construction (announced, completed, under construction) - 1973," Atlanta Chamber of Commerce, Atlanta, Georgia, June, 1974.

50. The Community Builder's Handbook, Urban Land Institute, Washington, D.C, 1968.

51. Census of Agriculture, County Data, U.S. Department of Commerce, Bureau of the Census, Washington, D.C., 1969.

52. Brown's Directory of North American Gas Companies, Harcourt, Brace, Javonovich Publishing Co., 1970.

53. Personal Communications: Dan Mathews PEDCo-Environmental Specialists, Inc., Cincinnati, Ohio.